Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

AUGUST 1955

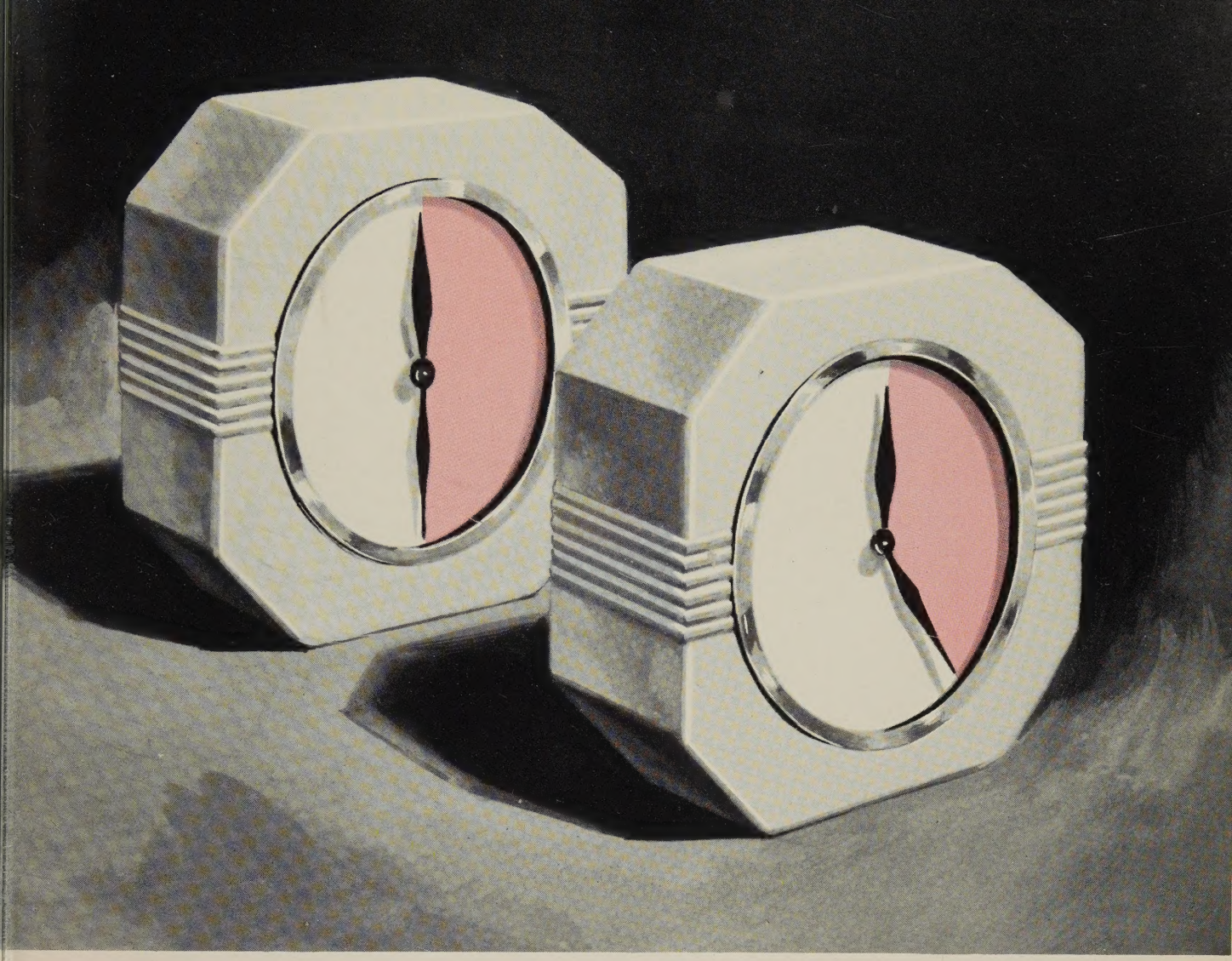
VOLUME 38 • NUMBER 8

Chinese fruit dish of tinned copper, with Yang-Yin symbol featured as centerpiece design.

This symbol (Yang-Yin) represents T'ai-chi, the old Chinese *Ultimate Principle*, and as such, perfection. As the Asten-Hill trademark it symbolizes the *best* in paper mill DRYER FELTS.

ASTEN-HILL MFG. CO.
Philadelphia 29, Pa.
Walterboro, S.C.

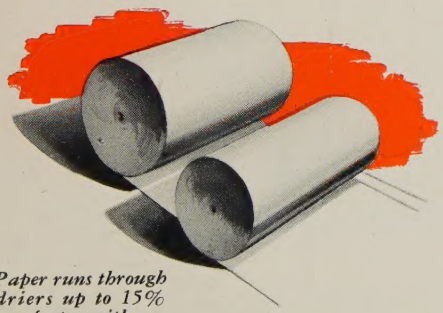
ASTEN-HILL LIMITED
Valleyfield, Quebec



Drying time reduced up to 15% with Alpha Protein®

...THE HIGH SOLIDS COATING ADHESIVE FOR OFFSET PAPERS

Solids in coatings increased up to 12% by ALPHA PROTEIN



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Now you can cut the costly expense of drying machine coated offset papers by as much as 15%. Glidden is doing it today for many leading paper coaters with Alpha Protein. You don't have to tie up costly equipment to find out what this superior adhesive can do for you. Glidden Technical Service men have the equipment to pilot test it in their own laboratories under similar conditions found in your plant. Call Glidden for fast, competent service on all of your high solid coating needs.

This advertisement is printed on paper processed with Glidden Alpha Protein. It is typical of the superior reproduction that can be obtained.

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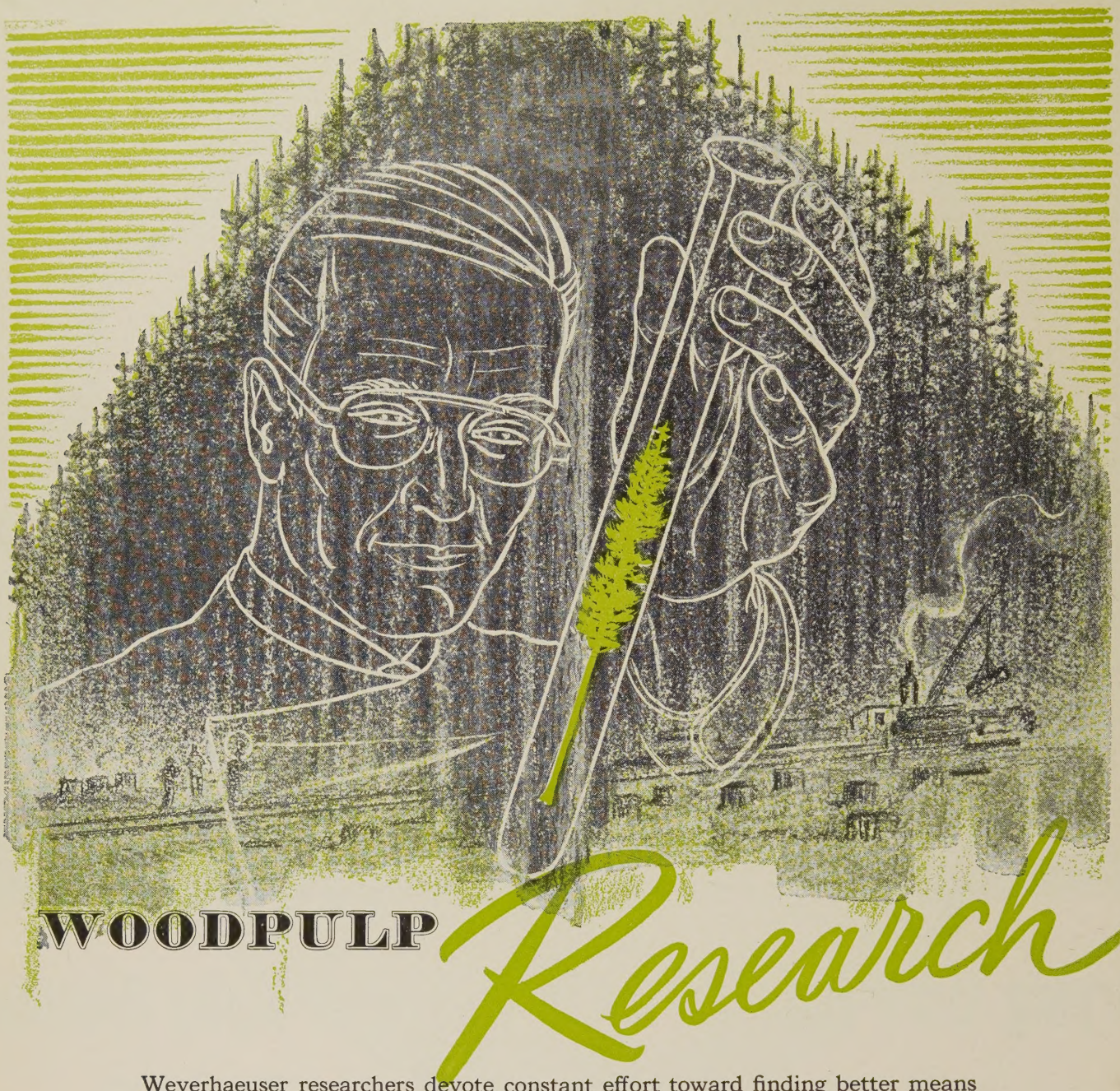

WOODPULP *Research*

Weyerhaeuser researchers devote constant effort toward finding better means to efficiently process woodpulp for papermakers in a competitive market. Stronger, better fibres result in paper and paper products unequalled for their superiority in either domestic or foreign competition. Woodpulp research is moreover carried on so that more *new* products from woodpulp can be economically manufactured.

Indeed, from woodpulp to paper is merely part of the story. From pulp to cellophane, photographic film, sausage casings, lacquers, plastics, smokeless powder, and endless other products would still not give the whole picture. Researchers are every day developing significant new products from woodpulp to improve our living.

It is therefore clear why the Weyerhaeuser Timber Company, through its research facilities and its scientific methods of tree farming and manufacturing, is dedicated to supply—without interruption—the woodpulp that industry requires.

PULP DIVISION **WEYERHAEUSER**

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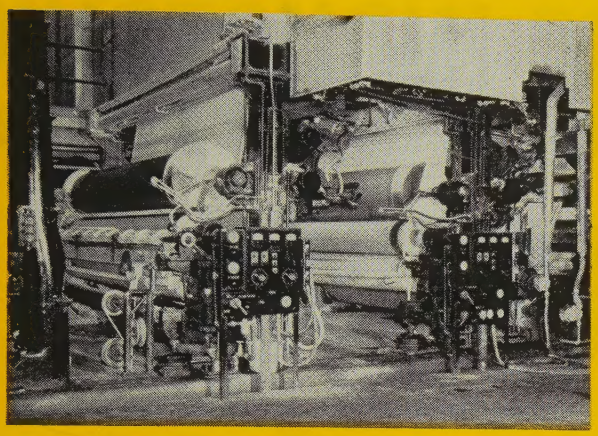
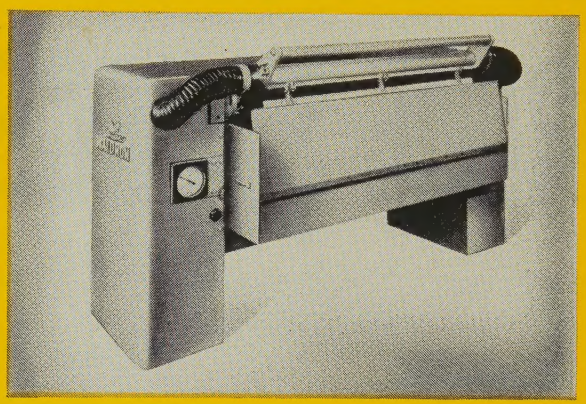
SYNCROSET* and MICROJET*

*Registered Trade Mark



coating units producing quality coated paper and board at some of the world's largest mills



Above: Machine coating at high speed with a WALDRON Syncroset Coater. At right: WALDRON Microjet Coater featuring the exclusive Waldron "Uniflo" nozzle.

Proof of their better design, sturdier construction and operating advantages is best reflected in the list of 58 prominent users

Alliance Paper Mills Ltd.
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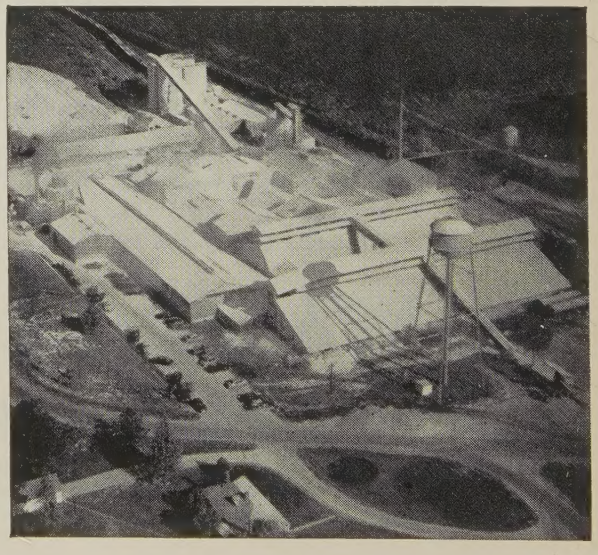

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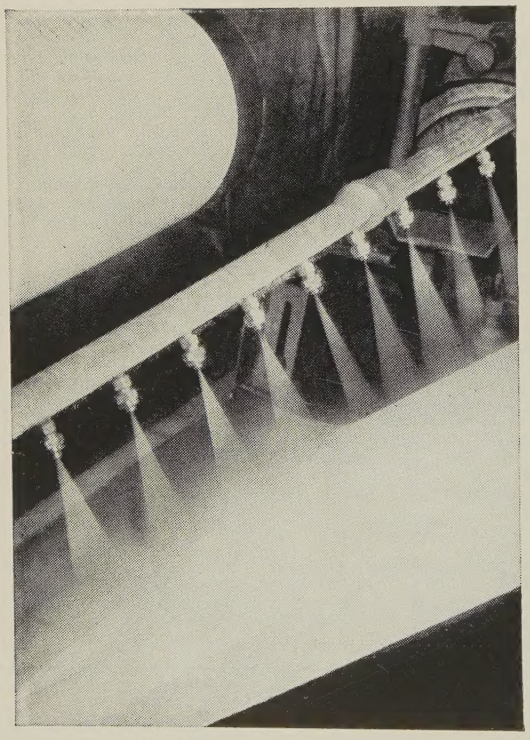
These Drops Tell the Story:

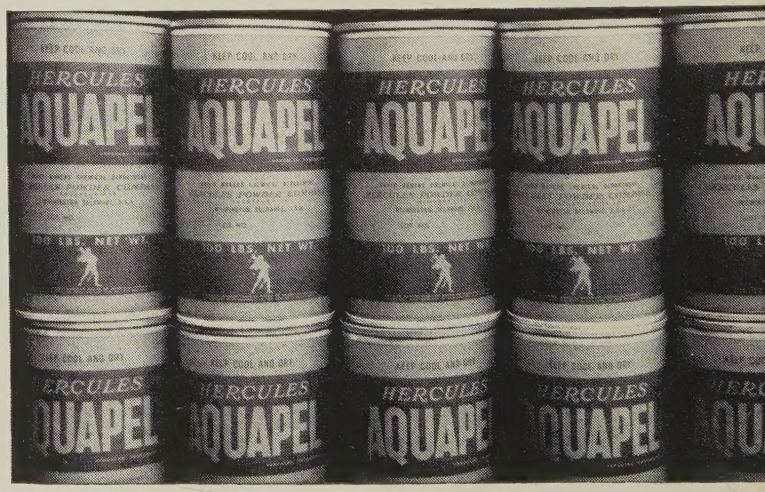
ACID, WATER, OR ALKALI...

THE PHOTOGRAPHS at right were taken under identical conditions —with one exception. In each case, drops of acid, water and alkali were placed simultaneously on the same grade of paper. But one sheet had been conventionally sized, the other Aquapel sized. That was the only difference—but what a difference:

The sheet conventionally sized has already begun to absorb the acid and alkali. Only the water has been repelled. But on the sheet sized with Aquapel, all three — acid, water and alkali — failed to penetrate. It's little wonder, therefore, that paper mills everywhere are investigating the 'Aquapel Difference.". . . .



EASY TO APPLY—Aquapel may be applied with any equipment commonly used for surface treatment of paper, such as size tub, size press, calender box, or coating machine. Aquapel dispersions can also be applied by spray equipment such as shown here. We would be glad to tell you the advantages of this new method.



100-POUND DRUMS—Aquapel is available in convenient, easy-to-handle fiber drums containing 100 pounds net.

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HERCULES POWDER COMPANY

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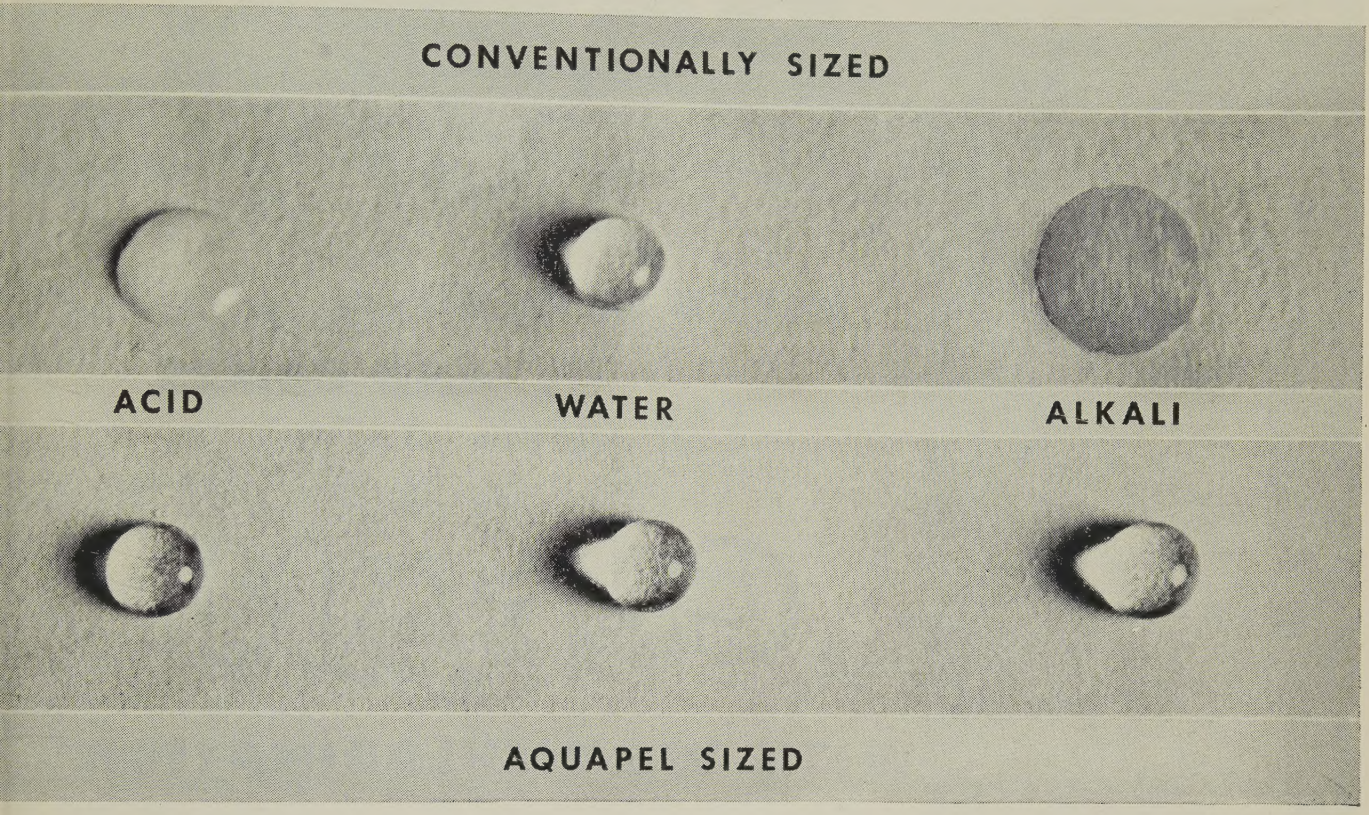
IT'S ALL THE SAME TO AQUAPEL®



. . . . Aquapel is a different kind of sizing agent. It's not a resin, not a wax. Aquapel is an alkylketene dimer, a chemical compound that reacts with cellulose fibers to form a surface that is resistant to the penetration of cold water, hot water, acid, or alkali.

Aquapel is different because it becomes an integral part of the material treated. It is not held on solely by adhesion or other physical means.

Aquapel is different because while usually applied on the surface, it is not a surface size in the usual sense. It replaces rather than supplements beater sizing with rosin size and alum.

And Aquapel is economical to use—a little goes a long way.

Why not find out for yourself what a difference Aquapel can make. Write for technical data and a sample.

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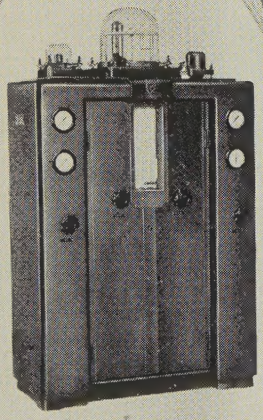
PP55-5

PAPER

KEEPS COMING...
...AND COMES

CLEAN

WITH W&T CHLORINATION



No slime formers . . . no contaminating organisms . . . no objectionable tastes, odors or colors . . . paper keeps coming without a slime break, and comes *clean* when a Wallace & Tiernan Chlorination system safeguards the fresh and white waters.

Whether your mill produces pulp, newsprint, kraft, writing, tissue, or board, the quality of your product and the efficiency of your mill depend on clean, biologically pure water. For information on how to get biologically pure water most economically, write our Industrial Division.

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The difference is—

PAREZ® Resin 607 is as efficient as an 8-armed paperhanger

Once in your paper mill, PAREZ 607 goes to work like a one-man gang. Here are the 8 big jobs it does—the 8 big reasons why PAREZ 607 is preferred by so many mills:

1. **PAREZ 607** delivers wet strength *at the reel.*
2. **PAREZ 607** gives consistent results from grade to grade in all commonly used pulps.
3. **PAREZ 607** is efficient in low, high and neutral pH's, and at lower drier temperatures, too.
4. **PAREZ 607** needs no alum or catalysts . . . reduces wet press sticking.
5. **PAREZ 607** cuts beater time and power costs . . . gives better drainage, faster drying, higher dimensional stability and lower tendency to curl.
6. **PAREZ 607** improves wax and rosin size efficiency . . . gives less foam trouble on machines, less "pitch" in systems.
7. **PAREZ 607** dry powder in bags means lower shipping costs, easier handling, less storage space . . . and, it has a shelf life well over a year.
8. **PAREZ 607** is a MELOSTRENGTH® resin, the fastest mover in the paper market . . . backed by the national MELOSTRENGTH Promotion Program.

Every one of these reasons spells profit. So ask your Cyanamid representative for full details on how to get and how to use PAREZ 607.

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Recent Mill Developments With Cyanamid's Paper Chemicals . . .

Don't judge the effect of size color on paper brightness until you try it. Recent tests of a number of sizes in bleached sulphite pulp showed that color of size is not wholly related to brightness of sized paper. Your Cyanamid representative can give you the details.

* * *

Highest pick test a western mill has ever had on starch coated offset sheet was secured by addition of PAREZ 620 Resin at rate of 20% on starch weight. Dennison Pick went from 11 to 20 on felt side, and 14 to 20 on wire side.

* * *

Pigment usage is halved in super white coated board by an eastern mill through addition of 1% sodium phospho aluminate as aid in filler and fiber retention. The saving in titanium dioxide pigment is $4.50 per ton of board over and above cost of added S. P. A.

AMERICAN Cyanamid COMPANY
PAPER CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

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Fresh, "clean white" for bread and other food wrap helps complete the sale —both to your customers and the ultimate consumer. And to give bread wrap, waxed board, glassine and parchment lasting, sales-winning "whiteness," there's nothing like Du Pont TI-PURE titanium dioxide pigments.

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Time-tested TI-PURE pigments are now offered direct to you by Du Pont, and are sold only under the name, TI-PURE. For more information, or for help with a pigmenting problem, call our nearest district office. Our technical experts, backed by a modern paper laboratory, will be glad to help. There's no obligation, of course. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Wilmington 98, Delaware.

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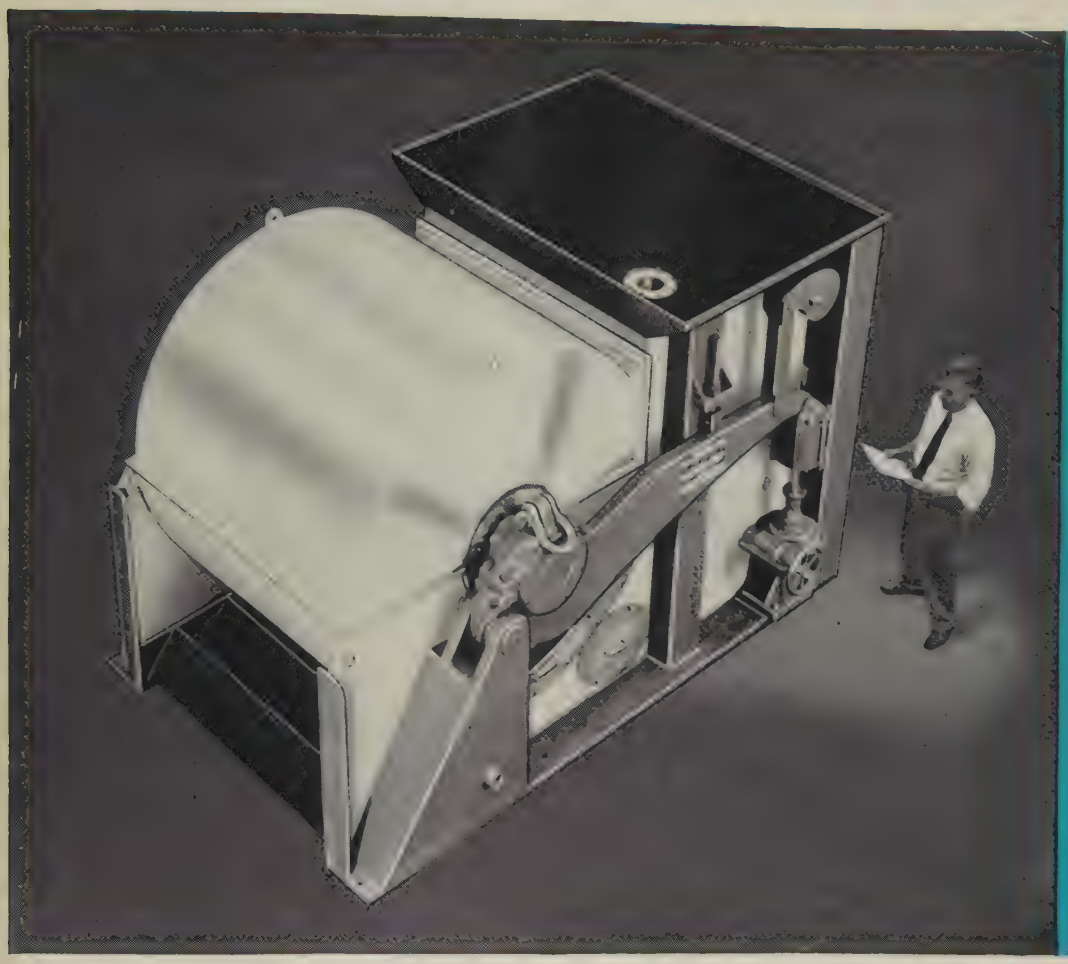
FACT:

Every glassine mill but one (now built or being built) has selected Jones Beating Units for its best grades



WHY?

Why this overwhelming preference for one machine for this tough assignment?

BECAUSE . . .

the Jones Beating Unit has proved, in mill after mill, that it will produce greater uniformity, better transparency, better all 'round characteristics — *at lower power cost.*

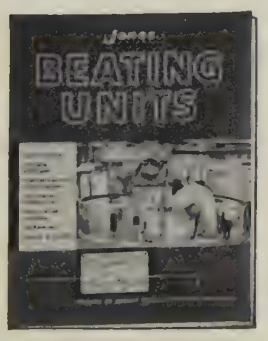
A leading glassine mill* writes:

> "Our experience . . . has convinced us that they are capable of producing high grades of glassine...which cannot be duplicated by any other equipment."

Glassine, of course, is only one of many papers on which the Beating Unit has produced such results. Ask your Jones representative how it can serve your needs.

*Name upon request

JUST OFF THE PRESS — Write today for your copy of this new Bulletin giving details about the Beating Unit. Ask for Bulletin No. EDJ-1079.



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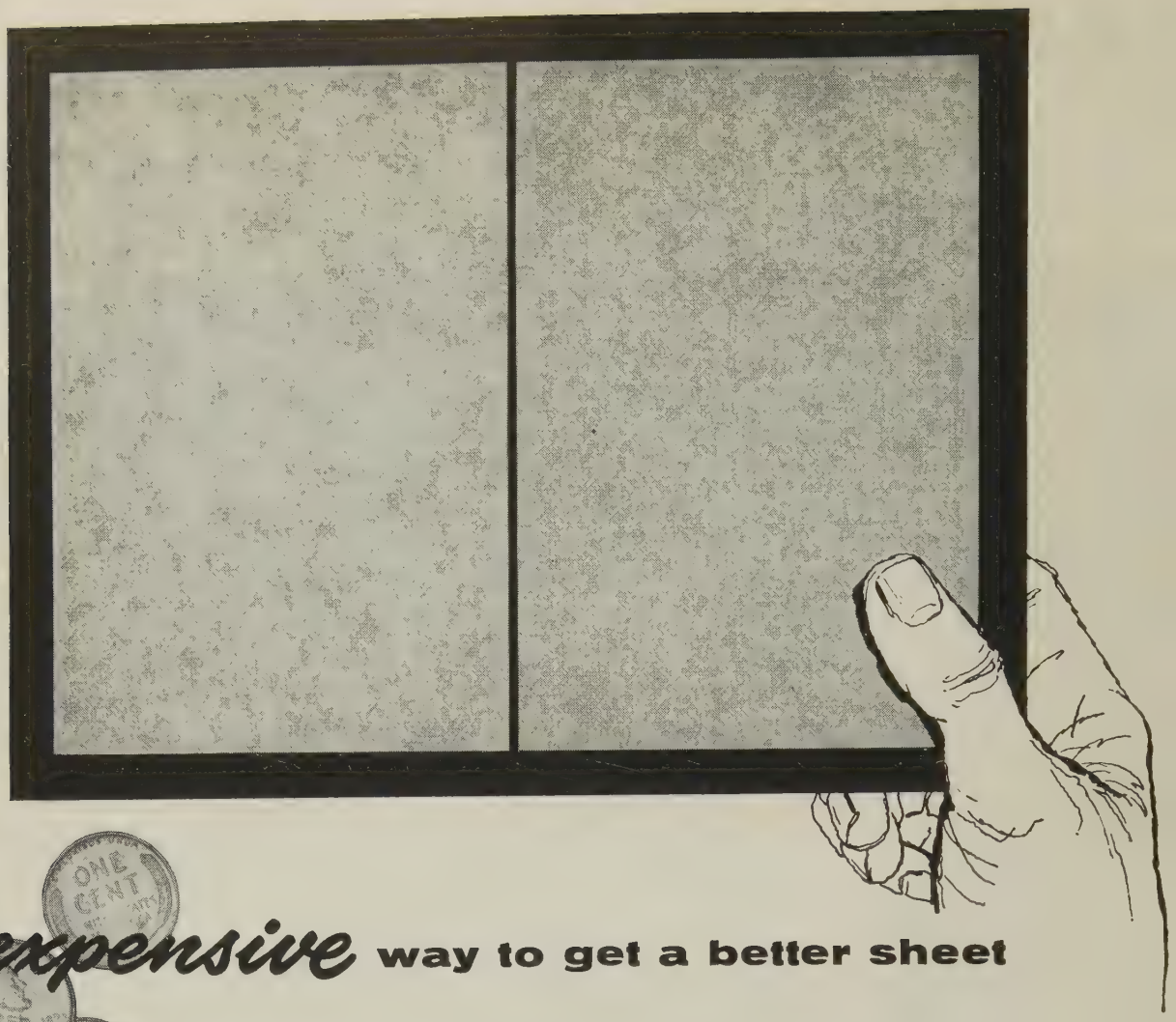

Inexpensive way to get a better sheet

This unretouched photograph illustrates the improved sheet formation you can expect from Dicalite paperaids. The two sheets of 50-lb. offset paper, which were photographed with a strong light behind them, are identical except in one thing—the sheet on the right contains 2% Dicalite by weight.

This improvement in sheet formation is due largely to the diatomaceous structure and the size of the microscopic Dicalite particles. Dispersed evenly through the stock, they prevent clumping and uneven felting of the fibers during formation and promote uniform distribution . . . which means, of course, a smoother, more even sheet. Also, because of the porous nature of the Dicalite particles, there is more rapid drainage of water from the sheet on the wire, resulting in faster drying. This can lead either to increased machine speeds or to savings in fuel costs.

Actually, in many cases, Dicalite paperaids don't even cost fractions of pennies. With increased machine speeds, meaning greater production, and Dicalite's other benefits, these paperaids may even save you money. The excellent suspending qualities of Dicalite result in higher retention of the fine fibers. Savings of bleached sulphite, particularly in liners, with no loss in strength or brightness, have been noted in many cases.

DEPENDABLE SERVICE TO INDUSTRY
25 YEARS
Dicalite
1930-1955

There is no room here even to mention Dicalite's other benefits in pitch control, bulking, better printability, pigment extension and so on. For full information, write for Dicalite Technical Bulletin F-52.

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PLIOLITE LATICES – general purpose, butadiene-styrene copolymers – elastomeric to resinous in nature – "hot" and "cold" types

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The Finest Chemicals for Industry — CHEMIGUM · PLIOBOND · PLIOFLEX · PLIOLITE · PLIO-TUF · PLIOVIC · WING-CHEMICALS

THE FUTURE OF EXPORTS IN THE UNITED STATES PAPER INDUSTRY

LOUIS T. STEVENSON

FOREWORD

For some time we have periodically issued studies by Dr. Stevenson concerned with the paper industry. Herewith we present his latest forecast "The Future of Exports in the United States Paper Industry."

The effect of increased exports is to raise the production above that needed for domestic consumption. The consequent effect of heavy exports on required production capacity is one of the important aspects weighed in this study.

Tucker, Anthony & Co.

THE increase in activity in the field of exports in the pulp and paper industry has been the subject of recent comment in the industry.

Frequently the great discrepancy between per capita consumption in the United States and certain other countries is cited as justification for the expectation of great increases in total world consumption. The argument runs about like this: United States per capita consumption is 20 times that of the rest of the world's 20 lb. An increase of 1 lb. per capita in the rest of the world would not be much to expect but it would mean a million tons. Therefore, the assumption is that great increases in total world tonnage can be expected from the underdeveloped portions of the world where the United States and the United Nations "Point Four" programs are active.

How valid is this? How much of an increase can be expected to be effective on the production of the United States paper industry from this source by, say, 1960 for example?

This paper will examine this problem and attempt to come up with rational conclusions.

In our analysis we will make use of recent publications of the (1) Food and Agricultural Organization of the United Nations, (2) publications of the Organization for European Economic Cooperation, (3) the study by the Stanford Research Institute made for the Weyerhaeuser Timber Co. and generously and widely distributed by them.

Having done some work in the field we are accepting the Stanford forecast of United States paper consumption as reasonable for the period through 1975, although differing somewhat with Stanford's forecast of net imports because of developments that have occurred since the Stanford report was completed. Net imports are, of course, imports less exports.

LOUIS T. STEVENSON, Economist, Tucker, Anthony & Co., New York, N. Y.

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UNITED STATES A NET IMPORTER

The United States has characteristically been an importing country of both pulp and paper. We consume about 60% of world paper supply and produce about 50% with a net import balance of almost 5,000,000 tons of paper, principally newsprint from Canada. Newsprint and wood pulp are duty free in the United States. All other papers carry tariff duty consequently the bulk of the United States imports are either newsprint or wood pulp.

Table I shows the record of United States consumption, production, and net imports of paper and board for the years 1952 and 1954, and a forecast of these for the years 1960, 65, and 75 made by the Stanford Research Institute for the Weyerhaeuser Timber Co.

Table I

	Actual		Stanford report				
United States	*1952*	*1954*	*1954*[a]	*1960*	*1965*	*1970*	*1975*
Consumption	29.0	31.1	31.1	37.4	42.7	47.9	53.5
Production	24.4	26.7	26.3	32.0	36.9	41.6	46.6
Net imports	4.6	4.4	4.8	5.4	5.8	6.3	6.9

[a] Interpolated from Stanford report.
Sources: 1952 and 1954 A.P. & P.A.; 1960, 65, 70, 75—Stanford Research Institute. The 1952 data also agree with Stanford Research Institute.

Recent developments indicate that there may be some changes developing in "net imports" which if they come about, as it now seems probable, will affect United States production.

It will be noted that between 1952 and 1954 production increased at a faster rate than the rates shown in the Stanford report, while net imports dropped. Consumption, on the other hand, in 1954 corresponded exactly with the Stanford rate. While the term of two years is short for such a test, these changes appear to have significance upon further analysis.

If consumption remains in line with the Stanford report and net imports drop, production in the United States must rise to fill the gap. And that is what has been occurring in newsprint and other grades. This has been particularly true in 1954 and indications are for a continuance of the movement.

United States exports of paper and board rose slightly above the 1952 level while imports stabilized, making a net of 4.4 million tons imports as compared with 4.6 million in 1952. While this was occurring, production of newsprint was increasing in the United States as imports from Canada stabilized, and thereby hangs a tale.

Newsprint production in the south was started in 1940. It has been successfully competing with Cana-

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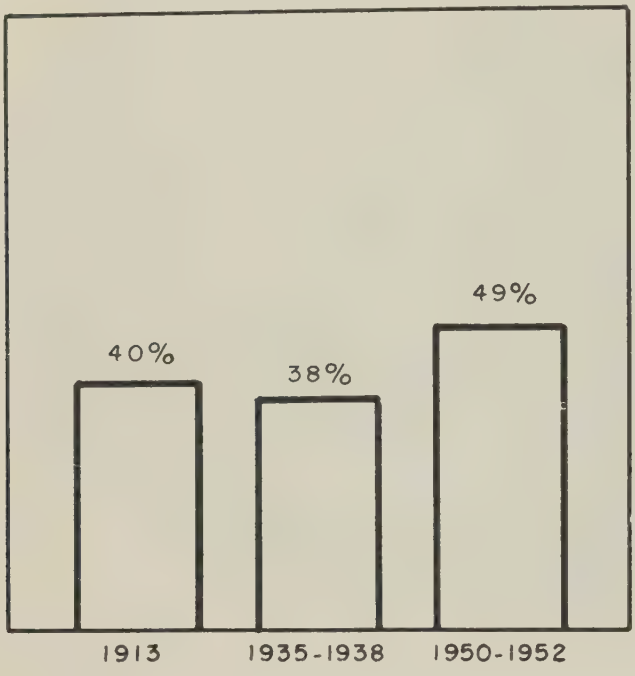
dian newsprint and there are now three large mills making newsprint, with a fourth being built, in that region. The first three southern mills are adding capacity. In addition to this the largest northern manufacturer is installing two modern machines to increase capacity through the use of chemiground hard-



United States' per cent of world paper production

wood. The size of this movement and the importance and character of those engaged in it justify the belief that it will continue to expand. It seems probable that imports of newsprint will be stabilized and may even decrease and that increases in domestic production in the United States will carry whatever increase in newsprint consumption may develop here. In this event it seems likely that the Stanford forecast should be modified with respect to "net imports" in the years 1960–75 to about the 1954 rate. The result could be an increase in domestic production of paper and board from 32 million to 33 million tons in 1960.

In some quarters the reasonableness of this may be questioned. As confirming facts supporting the position here taken, it should be noted that per capita consumption of newsprint has been practically stabilized for the 5 years 1949–53 at around 75 lb. per capita. Assuming that this rate holds through 1960, the increase in United States consumption of newsprint will be 535,000 tons or an average annual increase between 1954 and 1960 of 88,000 tons. United States newsprint production has increased by 123,000 tons during 1954 and comparatively little of the new capacity was operating throughout the year. During the year 1954, over 200,000 tons of annual newsprint capacity commenced operating and will be producing the full year of 1955. In addition to this, another 200,000 tons are due to come in in 1956, according to announced plans. And there is still more capacity coming in this present movement. By 1956 the United States capacity to produce newsprint will have reached 1,750,000 tons annually. Contrast this with an annual capacity of 1,073,700 tons in 1953. With these facts in mind and the additional fact that it is profitable to install United States newsprint capacity, it seems that the United States' production will increase as fast as the consumption increases during the period to 1975.

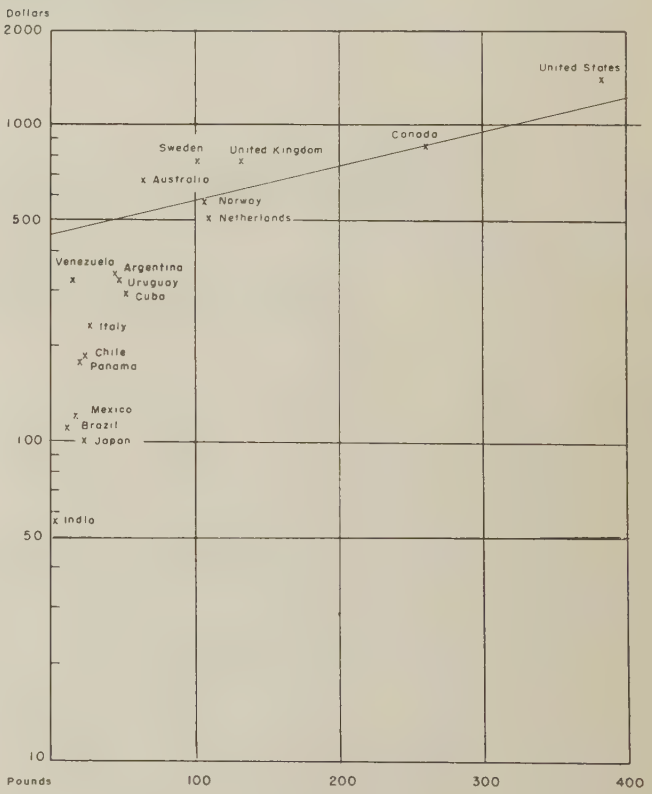
Opportunities for increases in Canadian newsprint production appear to rest upon prospective increases in Canadian exports to Europe and the rest of the world. These will be discussed later but it appears to be clear that the volume should be considerable.

Other trends are developing in the world pulp and paper industry which may mean additional demands for United States production facilities to handle.

There is some question as to the form in which the product will leave North America, whether as pulp or finished paper to supply the international deficiencies indicated. This aspect will be discussed later, but for the present, our discussion will deal with expected increases in consumption of paper by major geographical areas.

WOOD GENERALLY THE MOST ECONOMICAL RAW MATERIAL

It is an established fact that wood obtained in reasonable volume is the most economical raw material for



Source: F.A.O. and E.C.L.A. of United Nations.

Fig. 1. Per capita income and consumption by countries

papermaking. Other fibers are used such as straw, rags, jute, esparto grass, waste paper, bamboo, etc., generally as supplements to wood fiber.

Coniferous species such as spruce, hemlock, balsam and the pines have been the most generally used for pulpwood. Of late years hardwood species have been

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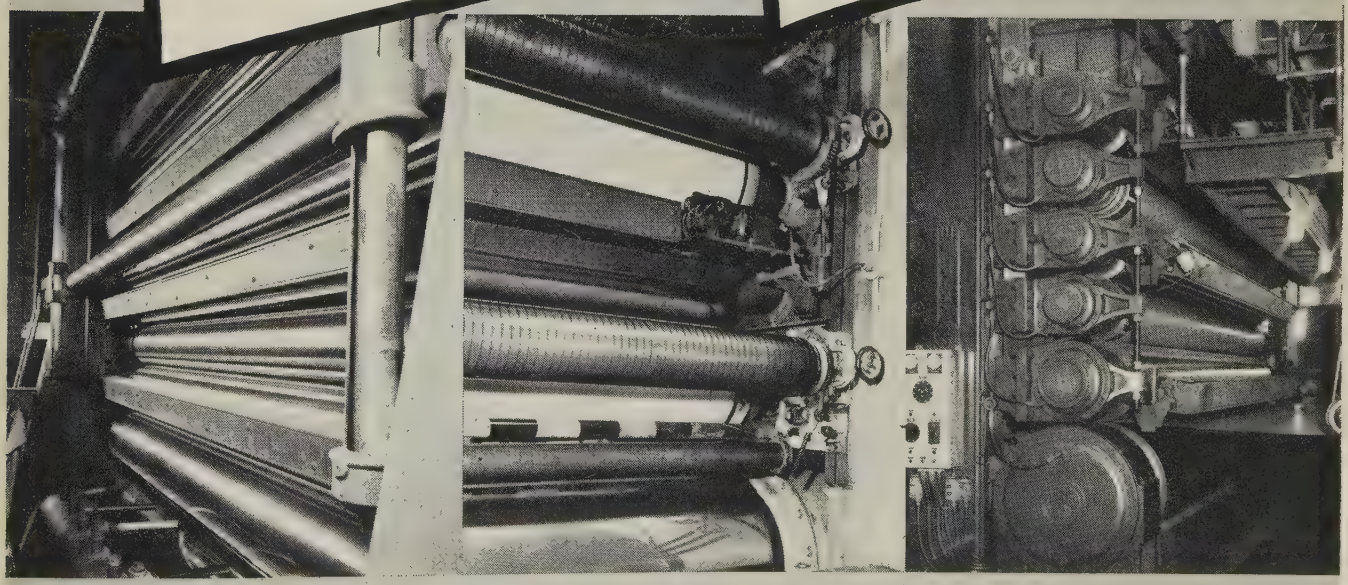

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successfully pulped to supplement the soft coniferous wood fiber in some grades of paper.

The world distribution of coniferous softwood has to a great extent determined the location of the existing world papermaking industry. In northeast Europe and North America are found the principal stocks of accessible softwood in the world today. Thus the United States, Canada, the Scandinavian countries, Germany, Austria, Czechoslovakia, and Poland made the great bulk of the wood pulp before World War II.

In northern Russia and Siberia there exist the greatest timber stands of coniferous wood in the world today. But these are relatively inaccessible and the cost of getting the wood out is excessive. Most of the Russian and Siberian rivers flow north into the Arctic and are frozen for much of the year. With the exception of the Baltic countries occupied by Russia, there is little of this vast wood supply that can be called easily accessible for papermaking.

South America has large hardwood forests and a patch of Parana pine in Southern Brazil.

Asian forests outside of Siberia are largely hardwood.

Australia and New Zealand have been pulping the eucalyptus but have supplemented it with imported wood pulp.

The vast continent of Africa has large stands of tropical hardwoods and a few tree farms in South Africa where coniferous wood has been planted and is now coming to maturity.

As has been said, availability is a prime requirement for the economical development of pulpwood. Except for Scandinavia where there is still some leeway, North America is the only part of the free world where there are large stands of available coniferous pulpwood. Hardwood is also abundant but at the present level of technology its use in papermaking is limited relative to the coniferous softwoods.

In part, due to the general practice of "tree farming" by the wood-using industries, the Stanford report concludes that by 1975 the United States will still be able to supply sufficient pulpwood to make the estimated production without strain on the relative price levels of competing products. The volume estimated by Stanford is 35,000,000 cords of softwood and $12^1/_2$ million cords of hardwood making a total of 47.5 million cords to be consumed in 1975. On this basis it is clear that the United States has ample wood resources in sight to meet the program outlined herein.

PRODUCTION—CONSUMPTION BY AREAS

A recent (1950–52) pattern of world distribution of paper is shown in Table II.

Europe was the principal regional exporter making and exporting 10% more than it consumed.

North America was practically self contained. Its net exports of half million tons were but 1.6% of its production.

North America and Europe produced over 90% of the total world volume of paper of which 62.2% was North American production. U.S.S.R. (Russia) which was not an exporter, made 4% according to estimates.

Total exports between the regions shown were just under 2 million tons (about 3.8% of the total) and this tonnage was widely scattered among all the rest of the world areas.

Figure 2 illustrates the relative growth of North American production since 1913 to its present dominant position.

It is clear from this analysis that the major production areas were—(1) North America and (2) Europe, with all other areas small factors in both production and consumption. These areas are relatively underdeveloped economically and their increases in consumption must be slow and in step with their economic development. Figure 1 shows that there is a rough relationship between per capita consumption and income per capita. Increases in per capita income in these regions are bound to be slow and the increase in consumption of paper and paperboard will be equally slow in developing. The high countries in per capita consumption are those with high per capita income and vice versa. This is logical and is confirmed by a look at the reasons for the high per capita consumption of the United States, the country which ranks highest in both income and consumption per capita.

Table II

	In millions of short tons			*Production, exported, %*	*Consumption, imported, %*
	Production	*Consumption*	*Exports*		
Europe	14.42	13.0	1.42	10	
North America	31.94	31.43	0.52	1.6	
Russia	2.12[a]	2.12[a]			
Latin America	0.89	1.60			44
Near and Middle East	0.033	0.11			70
Far East	1.65	2.11			22
Africa	0.10	0.50			80
Oceania	0.32	0.74			57
	51.47	51.61			

[a] Estimated.
Source: Food and Agricultural Organization of the United Nations "World Pulp and Paper Resources and Prospects" (New York, 1954), p. 8.

The high per capita consumption in the United States has been building up for years. It is a function of the high literacy, the wide and almost complete coverage of advertising media, the extensive transportation facilities, and above all the unique methods of distribution which are used in this country. These are the result of years of development and will scarcely be approached in a short time by the "Point Four" countries.

It will be seen from the following analysis that the consumption in the United States (37.4 million tons in 1960) will continue to be the backbone of world consumption at least through 1960. The United States has the most complete and accurate data on its production and consumption and it is felt that the forecasts of consumption for this country are more reliable than those for other areas.

Regional increases are shown in Table III.

North American increases will be supplied by increased production in that region.

According to the recent study of the Organization for European Economic Cooperation, Europe's forests outside of Russia and her satellite countries, can furnish wood for a potential additional 1,400,000 tons of wood pulp. That must result from intensive cultivation and utilization of European forested areas.

Depending upon the grades made, this pulp tonnage

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can be "stretched" to about 2,250,000 tons of paper by adding waste paper and other fibers, based on American product mix and practices. This would leave a European deficit of about 1,250,000 tons of paper and board in 1960 below the forecast.

Apparently this can come only from North America which still has available large coniferous forest resources.

Table III
Consumption millions of short tons

	1954	*1960-62*	*Increases*
Europe	14.5	18.0	3.5
North America	34.83	42.6	7.77
All other	8.185	10.6	2.41

Source: Ibid., p. 9, Table 7, the 1954 data are estimated by interpolation.

The same deduction may be made concerning the 2,410,000 tons increase in consumption forecast for the rest of the world. This will result in total increases of

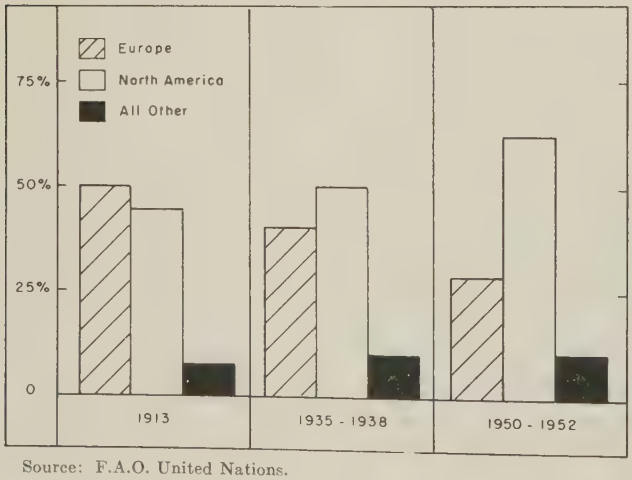
	Paper and paperboard
	1,250,000 tons for Europe
	2,410,000 tons for other areas
Total	3,660,000 tons

for which wood supplies may have to depend upon North America.

PAPERMAKING IN ALL COUNTRIES

As has been seen, papermaking is common to most countries. The limitations on its development include supply of raw materials.

Most of the consuming countries have paper production of some kind within their borders. It seems likely that increased demand will stimulate this to the extent of available resources. New fibers will be used and older sources of fiber will be developed. The recent conference at Buenos Aires indicates that the movement is already stirring. The so-called "dollar shortage" is

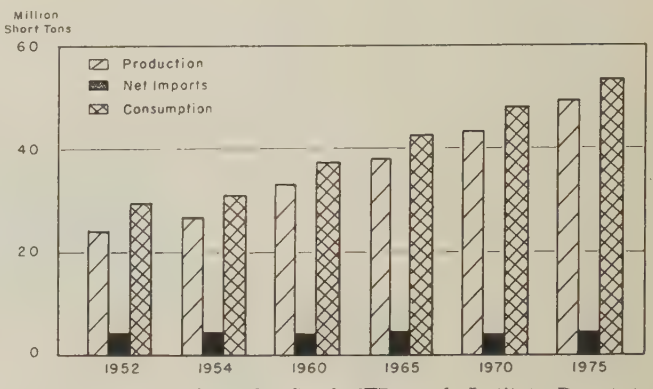


Source: F.A.O. United Nations.

Fig. 2. World production of paper and board, regional per cent of total

a prime stimulant to local production. Wherever possible, local fibers will be exploited. South America has straw, bagasse, several coniferous woods, and a great volume of hardwoods. It is not possible to judge at this time how much of her consumption increase can be supplied from these sources. The same kind of situations are developing throughout the world. In Asia and Australia the movement is on.

The recently developed hardwood pulping process will undoubtedly be used on the hardwoods of these regions to supply as much as possible of the deficit. How great a shortage will be left will depend upon many adjustments both in the economic and papermaking



Source: Consumption only, Stanford Research Institute Report to Weyerhaeuser Timber Co.

Fig. 3. U. S. production, net imports, and consumption —a forecast

fields. These are impossible to foresee, but it seems clear that outside tonnage either in the form of woodpulp or paper will have to come from North America, the only source where available supplies are open to the satisfaction of this demand.

Estimates for Europe

Europe has a well developed paper and pulp industry. It is already using many of the alternative fibers mentioned. On this premise it seems more likely that it will require pulp from North America than paper. Pulp can, of course, be used in European paper mills and it would be illogical and uneconomic to expect European papermakers to abandon their business when it could be continued by the purchase of wood pulp and other fibrous materials. An exception to this might prevail in newsprint, paperboard, and kraft paper, all of them produced on this side of the Atlantic. Under the circumstances, it is impossible to forecast the volume of wood fiber that would move from North America. European newspapers have been consumers of Canadian newsprint and will probably continue to be. Kraft paper and board may be shipped from our southern mills and, of course, wood pulp will move to Europe from North America. But in what volume it is not possible to forecast. At a guess the total volume might be 500,000 tons of newsprint and kraft paper and 750,000 tons of wood pulp annually by 1960.

Estimates for the Rest of the World

According to Table III, the requirements in the rest of the world will increase by 2,410,000 tons. The situation in these countries is akin to that in Europe with the exception that while papermaking exists it is not well developed in these areas. The limitation on purchasing foreign wood pulp set by exchange difficulties has hindered and limited the expansion of their domestic

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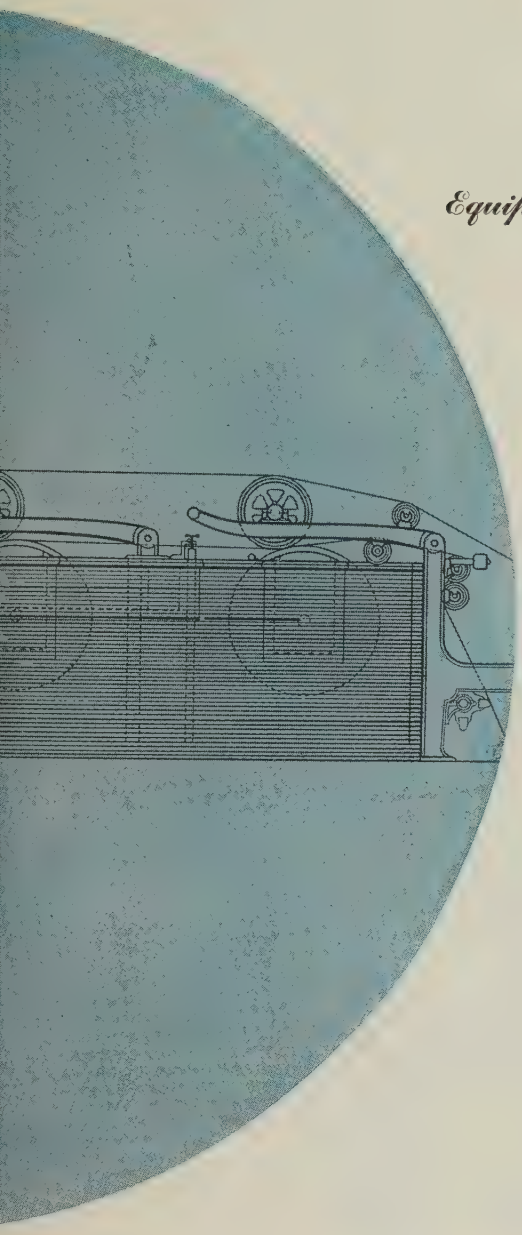

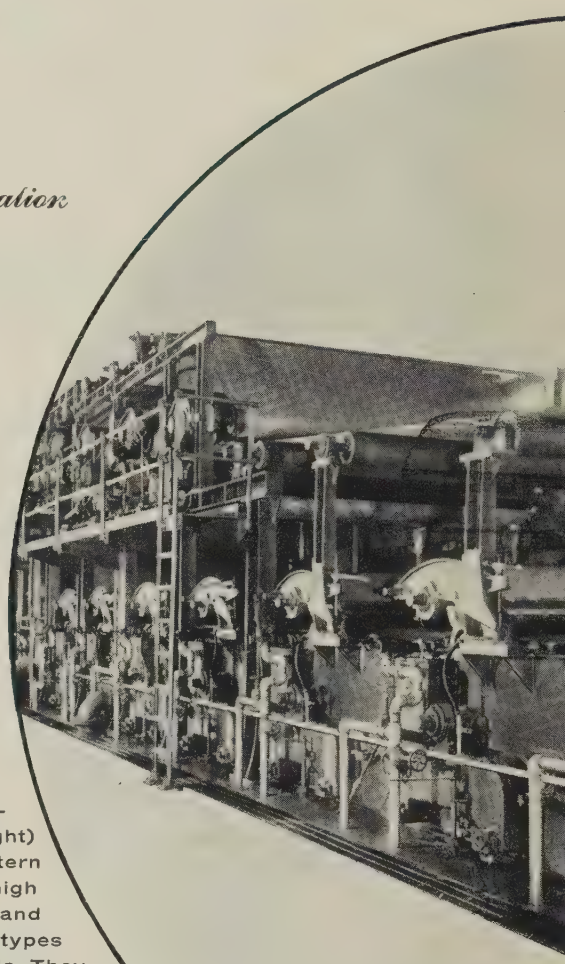

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paper production in the past and there is no assurance that it will not in the future.

The entire volume increase is spread over an immense population, something like 1,700,000,000 persons and this would average about 2.8 lb. per capita.

It seems probable that there will be some increases in imported wood pulp consumption in these countries. But this will depend upon the availability of the dollar exchange to purchase it. Taking the situation as a whole, it is believed that whatever increase in volume is developed in these regions will depend largely upon the use of local fibers by local paper mills. An increase in newsprint imports could occur but it likewise will depend upon availability of dollar exchange to pay for it. It is impossible to forecast the volume of either wood pulp or paper that will be required of North American producers. It is clear that there will be a certain volume however and for the sake of indicating this we are assuming that 20% of the increased demand will impinge on the North American industry. Let us say that 241,000 tons of paper, principally Canadian newsprint, will be required and that the wood pulp volume of 241,000 tons will be split between Canada and the United States.

WOOD PULP FOR NONPAPER USES

The use of dissolving pulp in Europe is expected to increase by about 167,000 tons from 1954 by 1960, according to the O.E.E.C.* As the principal consumption of this pulp outside of North America is in Europe, it appears that a world demand increase of 225,000 tons would represent a reasonable figure to use.

SUMMARY AND CONCLUSIONS

Table IV summarizes the increases in United States and Canadian volumes that are expected from the developments indicated above:

Table IV. Estimated Changes in the United States Paper Industry, 1954 and 1960

	1954	*1960*	*Increase or decrease tonnage, %*	
	(Millions of short tons)			
Paper and board consumption	31.1	37.4	+6.3	+20.0
Production	26.7	33.3	+6.6	+24.8
Net imports	4.4	4.1	−0.3	− 6.7

Estimated U. S. Wood Pulp Changes in Exports Between 1954 and 1960

	Increase in export tonnage, tons
Paper pulp	470,000
Dissolving pulp	150,000
Total increases	620,000

Estimated Canadian Paper and Pulp Changes in Exports Between 1954 and 1960

	Increases in exports to countries other than U. S., tons
Newsprint	600,000
Paper pulp	520,000
Dissolving pulp	75,000
Total increase paper and pulp	1,195,000

* "The Pulp and Paper Industry in Europe" the Organization for European Economic Cooperation (Paris, 1953).

The foregoing analysis indicates the belief that:

1. The increases in North America will be supplied from this continent's forest reserves.
2. Increases in European consumption of paper and board will come from European paper mills supplied by increases in Scandinavian wood pulp production, by fibers other than wood and by wood pulp imported from North America, and by shipments of Canadian newsprint and kraft paper and board from the United States.
3. Increases in consumption of paper and board in the rest of the world will come largely from local fibers procured by local paper mills using some wood pulp imported from North America. Canadian newsprint and United States kraft paper and board will in part supply the demand. Both wood pulp and paper imports will be limited by any dollar shortage that may occur from time to time.

Under these circumstances, the forecast for United States production, consumption, and net imports will look about as shown in Fig. 3.

Table V. Forecast for United States Paper and Board[a]
(Millions of short tons)

	1952	*1954*	*1960*	*1965*	*1970*	*1975*
Consumption	29.0	31.1	37.4	42.7	47.9	53.5
Net imports	4.6	4.4	4.1	4.1	4.1	4.1
U. S. production	24.4	26.7	33.3	38.6	43.8	49.4

[a] Source: Stanford report.

In countries where foreign exchange is "tight" the United States producer may find it advantageous in the long run to buy or build a mill in the foreign country and export "know how" and capital to run the mill. Thus he would be building up the country and avoid a strain on foreign exchange. West Virginia Pulp & Paper Co. is already doing this in Brazil and is reporting satisfactory results so far.

However, the principal volume of increase is going to be in United States production to meet the increased demand in this country. Whatever increase in United States exports to the world, will be the result of careful market analysis and thoughtful and consistent planning for individual markets rather than a haphazard approach. The market will be there but must be carefully and intelligently approached.

Regardless of the possibilities of export trade, the United States paper industry is going to need to increase its production facilities over 1954, by at least 6.6 million tons of paper and board by 1960. There is a good prospect of further capacity needs if the export possibilities outlined herein can be capitalized. This prospect will be greatly improved by a genuine easing of the world foreign exchange restrictions which have prevailed in recent years.

Technical Note on Forecasting

It is recognized that long range forecasting is hazardous because unexpected events may upset the conclusions reached. The forecasts herein are based on (1) the assumption that there will be no war, which would upset world economic forces and (2) that the armed services of the United States will continue to be maintained in a high state of preparedness. These forecasts are based on long-term trends and do not take into account intermediate fluctuations in the business cycle.

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PROPOSED AMERICAN SAFETY STANDARD FOR PULP AND PAPER MILLS

Final Report of Committees (April 13, 1955)

A REVISION OF AMERICAN TENTATIVE STANDARD SAFETY CODE FOR PAPER AND PULP MILLS, P1-1936

THIS revision of the tentative standard approved June 10, 1936, was made by a committee organized under the joint leadership of the National Safety Council and the American Paper and Pulp Association functioning under the rules of procedure of the American Standards Association.

The committee was carefully chosen to give fair representation to all interested groups.

The members of the present sectional committee are:

Organization Represented	*Name of Representative*
American Paper & Pulp Assoc.	Kenneth Faist
	Harley B. Goodrich, *Alternate*
	George V. Johnson, *Secretary*
American Pulp & Paper Mill Superintendents Assoc., Inc.	H. E. Weston
American Society of Mechanical Engineers	Charles J. Sibler
American Society of Safety Engineers	John H. Selden
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Black-Clawson Co.	David V. Smith
Chemipulp Process, Inc.	J. J. Carroll
Federal Security Agency Public Health Service	Dohrman H. Byers
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International Association of Governmental Labor Officials	A. A. Soldner
International Brotherhood of Paper Makers	Bart L. Tidland
International Brotherhood of Pulp, Sulphite and Paper Mill Workers	Raymond R. Richards
D. J. Murray Manufacturing Co.	C. L. Durkee
National Association of Mutual Casualty Cos.	Fred W. Braun
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Ontario Pulp & Paper Makers Safety Assoc.	Douglas B. Chant
The Paper Industry	
Quebec Pulp & Paper Safety Assoc.	Richard W. Porter
	A. S. Cook
Technical Association of the Pulp & Paper Industry	Charles J. Sibler
	William McIntosh, *Alternate*
U. S. Department of Commerce, National Bureau of Standards	John A. Dickinson
	William T. Jones, *Alternate*
U. S. Department of Labor Bureau of Labor Standards	Sheldon Homan
	Joseph S. Perzella, *Alternate*

Section 1—Scope and Purpose

Rule 1.1 Existing Standards

This Standard applies to establishments where pulp and/or paper are manufactured. This Standard does not include safety recommendations with regard to logging and transportation of logs to the mill. Nor does it list specific information on subjects such as illumination, guards for mechanical power transmission apparatus, and other subjects which are covered in detail in the Standards listed below. Where these Standards apply to paper and pulp mills, they are endorsed by the Sectional Committee and compliance recommended.

A9.1-1953	Building Exits Code
A11.1-1952	Industrial Lighting, Practice for
A12-1932	Floor and Wall Openings, Railings, and Toe Boards, Safety Code for
A13-1928	Scheme for the Identification of Piping Systems
A14.1-1952	Portable Wood Ladders, Safety Code for
A17.1-1937	Elevators, Dumbwaiters, and Escalators, Safety Code for (with Supplement, A17.3-1942)
A39-1933	Window Cleaning, Safety Code for
B7.1-1947	Use, Care, and Protection of Abrasive Wheels, Safety Code for
B13-1924	Logging and Sawmill Safety Code (NBS Handbook H5)
B15.1-1953	Mechanical Power-Transmission Apparatus, Safety Code for
B19-1938	Compressed Air Machinery and Equipment, Safety Code for
B20.1-1947	Conveyors, Cableways, and Related Equipment, Safety Code for
B30.2-1943	Cranes, Derricks, and Hoists, Safety Code for
B31.1-1951	Code for Pressure Piping, with Supplement, B31.1a-1953, and B31.1.8-1952
B56.1-1950	Industrial Power Trucks, Safety Code for
C1-1953	National Electrical Code (NBFU Pamphlet 70)
C2	National Electrical Safety Code (NBS Handbook H30)
K13.1-1950	Identification of Gas-Mask Canisters, Safety Code for
O1.1-1954	Woodworking Machinery, Safety Code for
Z2-1938	Protection of Heads, Eyes, and Respiratory Organs Safety Code for the (NBS Handbook H24)
Z4.1-1935	Industrial Sanitation in Manufacturing Establishments, Safety Code for
Z9	Fundamentals Relating to the Design and Operation of Exhaust Systems (Report published for comment)
Z12.1-1946	Installation and Operation of Pulverized-Coal Systems
Z35.1-1941	Industrial Accident Prevention Signs, Specifications for
Z37.1-1941	Carbon Monoxide, Allowable Concentration of
Z41	Protective Occupational Footwear, Specifications for (American War Standards)
Z49.1-1950	Safety in Electric and Gas Welding and Cutting Operations
Z53.1-1953	Safety Color Code for Marking Physical Hazards and the Identification of Certain Equipment

Copies of all of the above standards may be obtained from the American Standards Association, 70 E. 45th St., New York, N. Y.

Rule 1.2 Interpretations and Exceptions

The purpose of this Code is to provide reasonable

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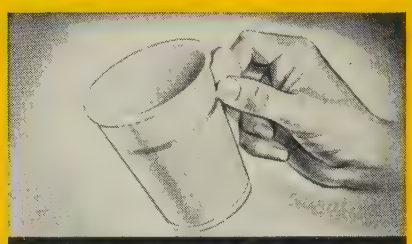

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safety for life, limb, and health. In cases of practical difficulty or unnecessary hardship, the enforcing authority may grant exceptions from the literal requirements of this Code or permit the use of other devices or methods, but only when it is clearly evident that reasonable safety is thereby secured.

Rule 1.3 Guards

All driving mechanisms, power transmission apparatus, and prime movers shall be constructed, guarded, and used in conformity with the applicable safety standard.

Rule 1.4 Clothing

Safety shoes, shin guards, hard hats, goggles, or other personal protective equipment shall be worn wherever indicated and maintained in accordance with applicable safety standards. Respirators, goggles, protective masks, rubber gloves, etc. shall be cleaned and disinfected before being used by another employee.

Rule 1.5 Floors and Platforms

Floors, platforms, and work surfaces shall be maintained in good condition, in accordance with applicable safety standards.

Rule 1.6 Fire Protection

All property, buildings, and structures shall be protected in accordance with applicable N.F.P.A. Codes.

PART I. THE YARD

Section 2—Handling and Storage of Pulpwood and Other Materials

Rule 2.1 Handling Pulpwood with Cranes or Stackers

(a) Where locomotive cranes are used for loading or unloading, the pulpwood shall be so piled as to allow a clearance of not less than 18 in. between the pile and the end of the cab of any locomotive crane in use, when the cab is turned in any working position.

(b) The minimum distance of pile from center line of standard gage track shall be maintained at not less than $8^1/_2$ ft.

(c) Logs shall be piled in an orderly and stable manner, so as to prevent projection into walkways or roadways.

(d) Railroad cars shall not be spotted on tracks adjacent to the locomotive crane unless clearance mentioned in 2.1 (a) can be maintained.

(e) The handling and storage of other materials shall conform to Rules 2.1 (a) and (b) with respect to clearance.

Rule 2.2 Handling Pulpwood from Ships

(a) Ladders to boat docks shall be of standard construction and shall be securely fastened in place. (See Section 1.)

(b) The hatch tender shall be responsible for the safety of the men working in the hold. He shall signal hoisting engineer to move the load only after the men are in the clear.

Rule 2.3 Handling Pulpwood from Flat Cars

(a) Flat cars for the conveyance of pulpwood—loaded parallel to the length of the car—shall be equipped with safety stake pockets.

(b) Where pulpwood is loaded crosswise of the car sufficient stakes of sizes not smaller than 4 by 4 in. shall be used to prevent the load from shifting on flat cars.

(c) When it is necessary to cut stakes, those on the unloading side should be partially cut through first, and then the binder wires cut on the opposite side. Wire cutters equipped with long extension handles are recommended. No person should be permitted along the dumping side of the car after the stakes have been cut.

(d) Flat cars shall be properly chocked during unloading.

Rule 2.4 Handling Pulpwood from Trucks

(a) Extreme care shall be used in unloading the pulpwood from trucks.

(b) When loads are dumped, workers shall stand in the clear.

(c) Cutting of stakes and binder wires shall be done in accordance with Rule 2.3 (c).

Rule 2.5 Cranes

(a) Cranes shall be of adequate capacity for the loads to be handled. (See Section 1.)

(b) A heavy chain for cable shall be fastened to the boom and to the frame of boom cranes, other than locomotive, at the base for security in the event of breakage.

(c) Crane boom and load capacities shall be posted in the cab of the crane for reference when making near capacity loads.

(d) When working in close proximity to overhead

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Health and Safety Supvr.
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General Safety Supvr.
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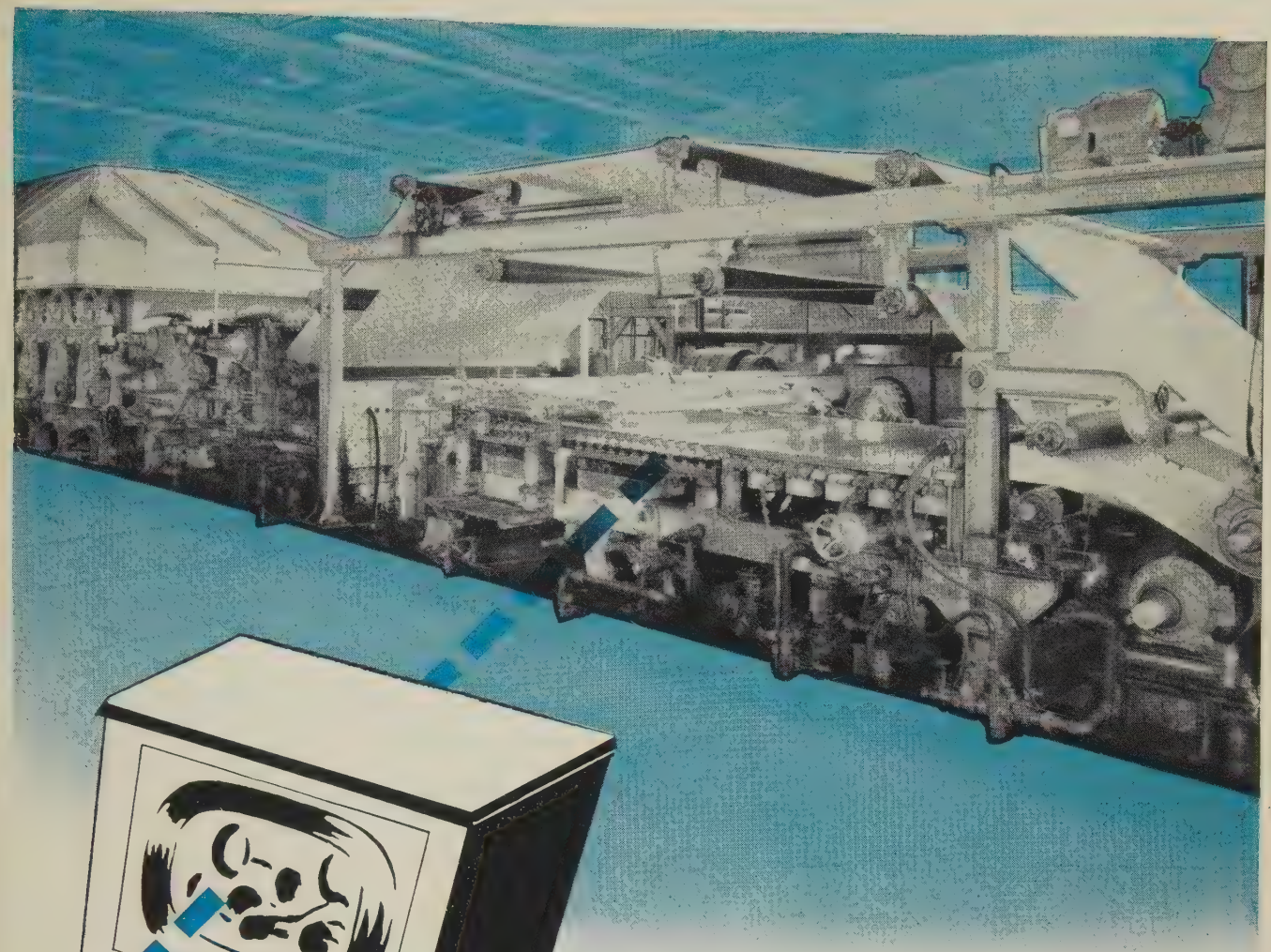

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wires or other overhead obstructions, a helper shall be delegated to watch and direct crane movements.

(e) Suitable signals for the operation of the crane shall be established for all movements of the crane. (See Section 1.)

(f) Only one member of the crew shall be authorized to give signals to the crane operator.

(g) Crane shall be equipped with suitable horn or whistle.

Rule 2.6 Traffic Warning Signs or Signals

(a) Provision shall be made for a warning signal or a flagman when cranes or locomotives are being moved over or across railroad tracks or roads and at other points where vision of the operator is restricted.

(b) After cars are spotted on side tracks for loading or unloading, the track shall be blocked by suitable warning flags or signs placed in the center of track at least 50 ft. away.

Rule 2.7 Illumination

Adequate artificial illumination shall be provided when loading or unloading is performed after dark (See Section 1.)

Rule 2.8 Bridge or Dock Plates

The construction and use of bridge or dock plates shall conform to requirements in A.S.A. Code B 56.1 (See Section 1.)

Rule 2.9 Barking Drums

When barking drums are employed in the yard, follow Section 7.

Rule 2.10 Hand Tools

(a) Wood hooks shall be made of good grade steel, correctly tempered. The handle shall be locked to the frame to prevent it from rotating.

(b) Peavies and Cant Hooks. The hook point shall be kept sharp and the hook bolts inspected for excessive wear.

(c) Pike Pole. The handle shall be made of sound material smoothly finished and free from splinters, burrs, or other defects. The point and gaff shall be kept sharp at all times.

Rule 2.11 Inspection and Maintenance

There shall be adequate inspection and maintenance of all equipment, including cranes, tracks, chains, cables, tools, and ropes.

Section 3—Wood Pile

Rule 3.1 Removal of Pulpwood

(a) To knock down wood from wood pile, mechanical equipment shall be used to permit employees to keep in the clear of loosened wood.

(b) If dynamite is used to loosen the pile, only authorized men shall be allowed to handle and discharge the explosive. A battery-operated electric detonator is preferable for firing this charge; but if fuse is used, it shall be approved safety fuse with a burning rate of not less than 120 sec. per yd. and the minimum length of fuse shall be 16 in.

Rule 3.2 Conveyors

(a) The sides of the conveyor shall be constructed so that the wood will not fall off.

(b) Where conveyors cross passageways or roads, a horizontal platform shall be provided under the conveyor extending out from the sides of the conveyor a distance equal to one and one-half times the length of the wood handled. The platform shall extend the width of the road plus two feet on each side of it and shall be kept free of wood and rubbish. The edges of the platform shall be provided with toe-boards or other protection to prevent wood from falling.

(c) All conveyors for pulpwood shall have the in-running nips between chain and sprockets guarded.

(d) Workman shall not under any circumstances ride on conveyors.

(e) Proper tools, such as pickaroons, shall be used for handling blocks on conveyors.

(f) When repairs are necessary on conveyors, the starting switch or lever shall be locked to prevent unauthorized starting.

Rule 3.3 Signs

Where conveyors cross walkways or roads in the yards, signs reading "Danger, falling wood," or equivalent warning shall be erected.

Section 4—Handling and Storage of Other Raw Materials

Rule 4.1 Individual Personal Protective Equipment

(a) Whenever possible, all dust, fumes, and gases incident to handling materials, shall be controlled at the source. Where not possible, respirators with goggles, or protective masks, shall be provided for workers handling alum, clay, soda ash, lime, bleach powder, sulphur, caustic soda, chlorine, and similar materials. (See Section 1.)

(b) When handling liquid acid or alkali, workmen shall be provided with approved eye and face protection, rubber gloves, and protective aprons. (See Section 1, Rule 1.4.)

Rule 4.2 Battery and Hand Trucks

(a) For power trucks see Section 29, Rule 29.

(b) For hand trucks see Section 30, Rule 30.

Rule 4.3 Pallets and Skids

(See Section 31, Rule 31.)

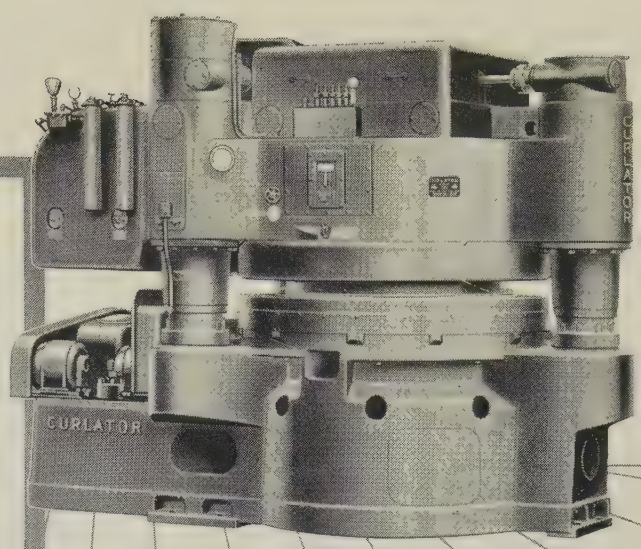
Rule 4.4 Clearance

(a) When piling materials inside buildings and upon platforms, sufficient clearance shall be provided for the safe operation of all trucks.

(b) Baled paper and rags stored inside the building shall not be piled against walls or partitions. A 3-ft. space shall be left in case of fire and subsequent expansion when wet.

Rule 4.5 Piling and Unpiling Pulp

(a) Piles of wet lap pulp shall be "stepped back" toward the top. Sheets of pulp shall be interlapped to make the pile secure; vertical or inclined wooden braces shall not be used. Pulp shall not be piled (1) over pipe lines to jeopardize pipes, or (2) so as to cause



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overloading of floors, or (3) to within 18 in. below sprinkler heads.

(b) Piles of pulp shall not be undermined when unpiling.

(c) Floor capacities shall be clearly marked on all floors.

Rule 4.6 Carboys

(a) Carboys shall be suitably marked or stenciled for dangerous content.

(b) Carboys shall be completely drained to avoid slops and spills when handling supposedly empty carboys, and stoppers or plugs shall be in place at all times.

PART II. PREPARING PULPWOOD

Section 5—Saws

Rule 5.1 Gang and Slasher Saws

A guard shall be provided in front of all gang and slasher saws to protect workers from wood thrown by saws. A guard shall be placed over tail sprockets.

Rule 5.2 Slasher Tables

No person shall be permitted on the slasher table when it is in motion. Saws shall be stopped whenever it is necessary for any person to approach within 6 ft. of the saw.

Rule 5.3 Slasher Drive Belts, Pulleys, and Shafts

All belts, pulleys, and shafts shall be guarded in accordance with standard requirements. (See Section 1, A.S.A. B15.1.)

Rule 5.4 The Runway to the Jack Ladder

The runway from pond or unloading dock to table shall be protected with standard handrail and toe boards. (See Section 1, A.S.A. A12.) Inclined portions shall have cleats or equivalent nonslip surfacing.

Rule 5.5 Guards Below Table

Where not protected by the frame of the machine, the under side of the slasher saws shall be enclosed with guards of standard materials.

Rule 5.6 Conveyors

Emergency stop devices for conveyors shall be provided within 10 ft. of each work station.

Rule 5.7 Single Circular Saws—Not Slasher Saws

Saw shall be provided with standard guards. (See Section 1, A.S.A. B13.)

Section 6—Hand Barking

Rule 6.1 Guards

The machine shall be equipped with a feed and turnover device which will make it unnecessary for the operator to hold a bolt or log by hand during the barking operation. Eye protection shall be provided for the operator. (See Section 1, Rule 1.4.)

Rule 6.2 Screens

Persons passing by the barkers shall be safeguarded from flying particles through the installation of a sheet metal or fine wire mesh guard.

Rule 6.3 Stops

All control devices shall be positively locked in the "off" position when changing knives.

Rule 6.4 Governor

Barker disks, when directly connected to a water wheel, shall be provided with speed governors.

Section 7—Machine Barking

Rule 7.1 Continuous Barking Drums

(a) When platforms or floors allow access to the sides of the drums a standard railing shall be constructed around the drums. When two or more drums are arranged side by side, proper walkways with standard handrails shall be provided between each set. (See Section 1, A.S.A. A12.)

(b) Sprockets and chains, gears, and trunnions shall have standard guards. (See Section 1, A.S.A. B15.1.)

(c) Whenever it becomes necessary for a workman to go within a drum, the driving mechanism shall be securely locked in the "off" position.

Rule 7.2 Intermittent Barking Drums

In addition to motor switch, clutch, belt shifter, or other power disconnecting device, intermittent barking drums shall be equipped with a device which shall be locked to prevent the drum from moving while it is being emptied or filled.

Rule 7.3 Hydraulic Barkers

Hydraulic barkers shall be enclosed with strong baffles at the inlet and the outlet. The operator shall be protected by at least five-ply laminated glass.

Rule 7.4 Mechanical Barkers and Routers

Such machines as the Stetson-Ross and Gruber barkers shall be equipped with at least five-ply laminated glass shields. The Stetson-Ross routers shall be fully enclosed and equipped with at least five-ply laminated glass to protect the operator.

Section 8—Splitters and Cleaners

Rule 8.1 Splitter Block

The block which the wood is rested upon or against shall have a corrugated surface or other means provided so that the wood will not slip. Wood to be split, also the splitting block shall be free of ice, snow, or chips. The operator shall be provided with eye and foot protection.

Rule 8.2 Power Control

Power for the operation of the splitter shall be controlled by a clutch or equivalent device.

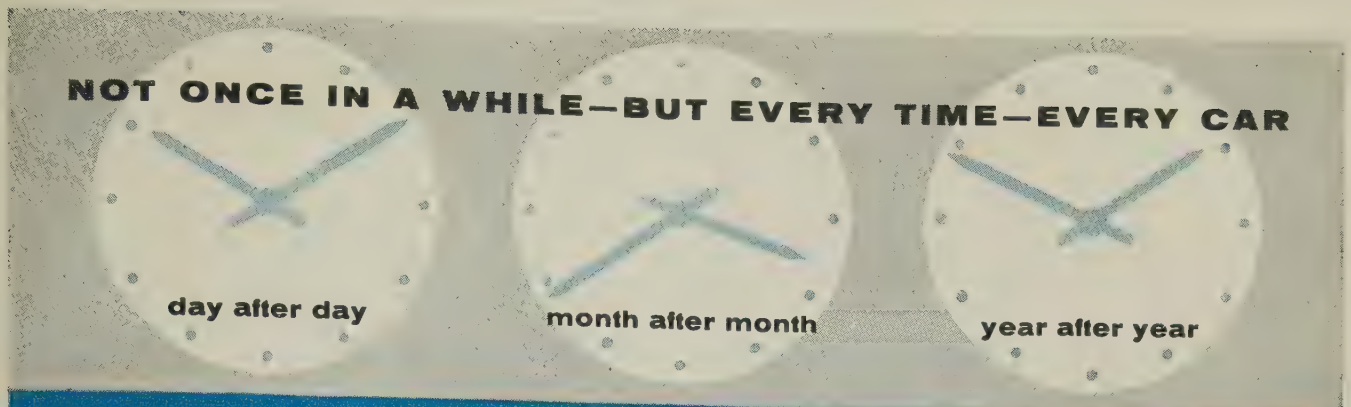
Rule 8.3 Knot Cleaners

Woodpeckers shall be enclosed as far as possible to protect passersby from flying chips. The operator shall be provided with eye protection.

Section 9—Chippers

Rule 9.1 Chipper Spout

The feed system to the chipper spout shall be ar-



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ranged in such a way that the operator does not stand in a direct line with the chipper spout. All chipper spouts shall be enclosed to a height of at least 42 in. from the floor or operator's platform. If practical, a mirror should be installed to enable the chipper feeder to see the chute.

PART III. RAG AND OLD PAPER PREPARATION

Section 10—Sorting Room

Rule 10.1 Disinfection

(a) Rags and old paper, unless known to be free from contamination, shall be sterilized before processing.

(b) Respirators, gloves, and aprons shall be worn by employees engaged in handling materials to be sterilized. (See Section 1, Rule 1.4.)

Rule 10.2 Ripping and Trimming Tools

(a) Hand knives and scissors shall have blunt points, shall be fastened to the table with chain or thong, and shall not be carried on the person but shall be placed safely in racks or sheaths when not in use.

(b) Hand knives shall be provided with leather, fiber, or nonferrous metal disk guards at the junction of the handle and the blade.

Rule 10.3 Sharpening Steels

Sharpening steels shall be provided with leather, fiber, or nonferrous metal disk guards at the junction of the handle and the steel.

Section 11—Rag Dusting, Shredding, and Cutting Machinery

Rule 11.1 Shredders, Cutters, and Dusters

(a) Rotating heads or cylinders shall be completely enclosed except for opening at feed side sufficient only to permit entry of stock—enclosure to extend over top of feed rolls. Construction to be of solid material or to have mesh or openings not exceeding $^1/_2$ in. and substantial enough to contain flying particles and to prevent accidental contact with moving parts, also to be bolted or locked in place.

(b) Smooth pivoted idler roll resting on stock or feed table, shall be provided in front of feed rolls except when arrangement prevents operator from standing closer than 36 in. to any part of feed rolls.

(c) Manually fed cutters, shredders, and dusters shall be provided with idler roll as per Rule 11.1 (b), or operator shall use special hand-feeding tools.

(d) Hoods of cutters, shredders, and dusters shall have exhaust ventilation. (See Section 1, A.S.A. Standard Z4.1.)

Rule 11.2 Blowers

(a) Blowers used for transporting rags shall be provided with feed hoppers having outer edges located not less than 48 in. from the fan.

(b) Arrangement of blower discharge outlets and work area shall be such as to prevent material from falling on workers.

Rule 11.3 Conveyors

(a) Conveyors and conveyor drive belts and pulleys shall be fully enclosed or, if open and within 7 ft. of floor, shall be constructed and guarded in accordance with A.S.A. Standard B20.1.

Rule 11.4 Ventilation and Dust Removal

Reasonable measures for the control of dust and dirt shall be provided.

Rule 11.5 Rag Cookers

(a) When cleaning, inspection, or other work requires that persons enter rag cookers, all steam, water, or other control devices shall be positively locked in the closed or off position. Blank flanging of pipe lines is acceptable in lieu of closed and locked valves.

(b) When cleaning, inspection, or other work requires that persons must enter the cooker, one person shall be stationed outside in a position to observe and assist in case of emergency.

(c) Air-supplied respirators should be worn by persons when spreading material inside cookers.

(d) Rag cookers shall be provided with safety valves of adequate capacity set not to exceed safe working pressures.

PART IV. CHEMICAL PROCESSES OF MAKING PULP

Section 12—Sulphite Process

Rule 12.1 Sulphur Burners

(a) Sulphur-burner houses shall be safely and adequately ventilated. Every precaution shall be taken to guard against dust explosion hazards and fires. (See Section 1, A.S.A. Standard 24.1.)

(b) Where sulphur is moved by conveyor, nonferrous buckets should be used.

(c) Sulphur storage bins shall be kept free of sulphur dust accumulation.

(d) Tools should be of nonferrous material and nonsparking type.

SUBCOMMITTEE ON RAG AND OLD PAPER PREPARATION
MECHANICAL PULP PROCESS, STOCK PREPARATION

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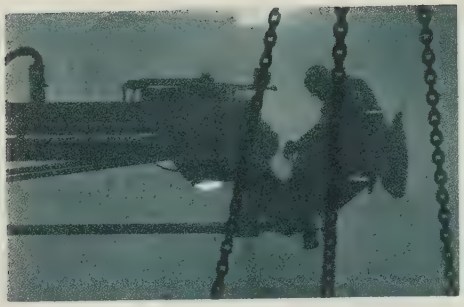
TORKEL KORLING

PEED SAND SLINGER *in the foundry at Beloit Iron Works.* / *For further details, please turn the page.*



SPEED SAND SLINGER

The photograph on the preceding page shows the main foundry bay at Beloit Iron Works, Beloit, Wisconsin. Hovering like a giant arm is the boom of the automatic sand slinger from which an almost invisible stream of sand is sprayed with the impact of rifle fire. By this means, each flask is evenly rammed, insuring a casting that is a true reproduction of the pattern. Careful technological control of sand characteristics and metal analysis is an important production factor. Result: castings of the highest obtainable quality.

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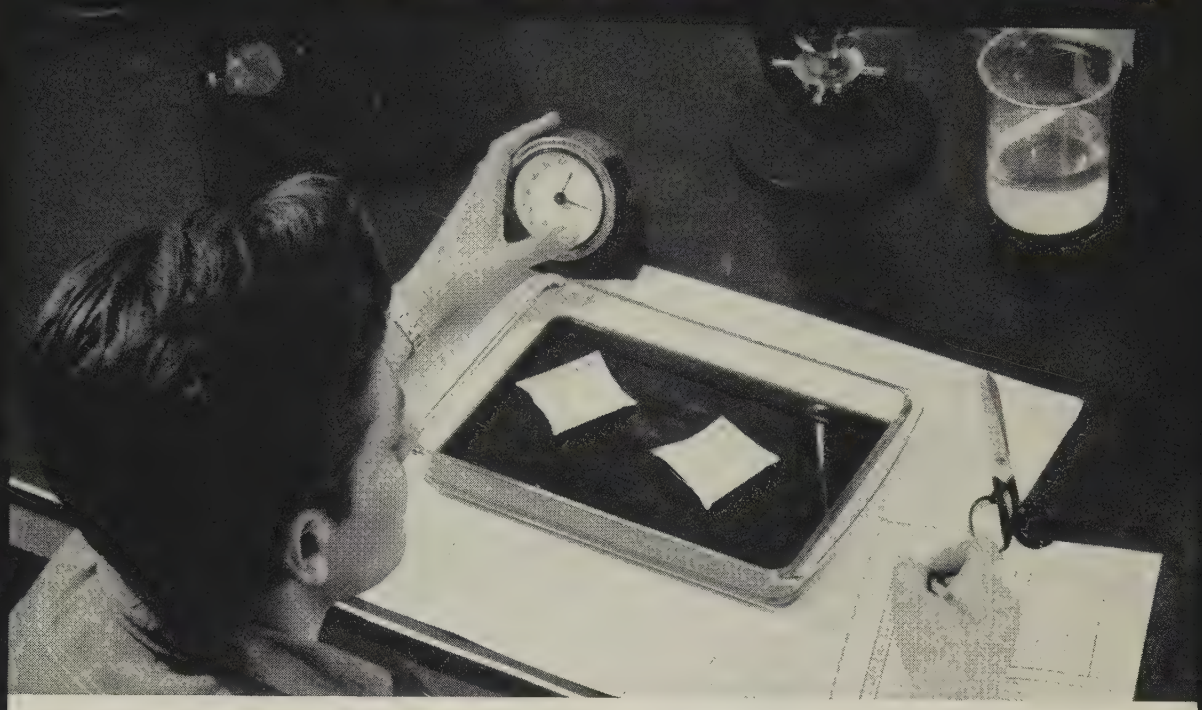

WITH INK FLOTATION TEST, a Byron Weston Paper Co. technician checks production samples of 100% rag paper for ink resistance and feathering. Mersize RM Dry's consistent high sizing meets Byron Weston's critical standards.

It takes uniform, quality sizing to keep a tight rein on the variables that arise in high-grade rag paper production. That's why Byron Weston Paper Company, of Dalton, Mass., relies on Monsanto paper chemicals.

When Mersize RM Dry was introduced by Monsanto last year, Byron Weston discovered that its high sizing stability brought great efficiency to production by reducing quality control fluctuations.

Byron Weston's technical staff says: "In making our 100% rag Weston Linen Record, we need insurance to control the variables. Mersize RM Dry's consistent sizing performance helps to narrow the margins of error and smooth out the extremes."

IF YOU USE DRY SIZE, it will pay you to check these other Mersize RM Dry advantages:

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LIGHT COLOR—Mersize RM Dry's very light color resists darkening with age... produces high-brightness paper comparable to the lightest rosin size.

LOW FOAM—Mersize RM Dry's low foam index helps eliminate countless production problems.

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Mersize CD-2 Dry
Concentrate in dry form
Mersize RM 70%
Complete fortified paste size
Mersize RM 77%
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(e) Electrical outlets shall be of nonexplosive type.

Rule 12.2 Protection for Employees (Acid Plants)

(a) Suitable gas masks, fitted with canisters containing absorbents for the particular acid, gases, or mists involved, shall be provided for employees of the acid department. Masks shall be conveniently located for emergency and rescue use. The masks shall be frequently inspected and maintained by competent persons. (See Section 1, A.S.A. Standard K13.1.)

(b) During inspection, repairs, or maintenance of acid towers, the workman shall be provided with eye protection, gas mask, a safety belt, and attached hand line. The line shall be extended to an attendant stationed outside the tower opening. (See Section 1, Rule 1.4.)

Rule 12.3 Clothing

Where lime shaking takes place, employees shall be provided with rubber boots and rubber gloves. A quickly available and easily applied water supply shall be provided to counteract any lime or acid burns. Employees handling limestone shall be encouraged to wear safety shoes and dust masks. (See Section 1, Rule 1.4.)

Rule 12.4 Acid Tower Structure

Outside elevators shall be inspected daily during winter months when ice materially affects safety. Elevators, runways, stairs, etc., for acid tower shall be inspected weekly for defects that may occur due to exposure to acids or corrosive gases.

Rule 12.5 Tanks (Acid)

There shall be no acid in tanks, and tanks shall be washed out with water and fresh air shall be blown in them before allowing men to enter. Men entering the tanks shall be provided with approved masks, life belts, and life lines and a man shall be stationed outside to summon assistance if necessary. All intake valves to a tank shall be blanked off or disconnected.

Rule 12.6 Lead Burning

When lead burning is being done within tanks, fresh air shall be forced into the tanks so that fresh air will reach the face of the worker first and the direction of the current will never be from the source of production of the fumes toward the face of the worker. Positive-pressure respiratory protective devices shall be provided.

Rule 12.7 Hoops for Acid Storage Tanks

Hoops of tanks shall be made of rods rather than flat strips and shall be frequently inspected and safely maintained.

SUBCOMMITTEE ON CHEMICAL PROCESSES OF MAKING PULP AND BLEACHING

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A. S. Caldwell
Safety Supervisor
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Marathon, Ont.

Rule 12.8 Chip Bins

(a) Steam or compressed air lances, or other facilities, shall be used for breaking down the arches caused by jamming in chip lofts. No worker shall be permitted to enter a bin unless provided with a safety belt—with line attached and an attendant stationed at the bin to summon assistance.

Rule 12.9 Exits (Digester Buildings)

At least one unobstructed exit at each end of the room shall be provided on each floor of a digester building.

Rule 12.10 Gas Masks (Digester Building)

Gas masks shall be available where gas may be encountered. These masks shall be such as to furnish adequate protection against sulphurous acid and chlorine gases, and shall be inspected and tested at frequent intervals—not to exceed 1 month. (See Section 1, A.S.A. Standard A17.1.)

Rule 12.11 Elevators

(a) Elevators shall be constructed in accordance with A.S.A. Standard A17.1.

(b) Elevators shall be equipped with gas masks for the maximum number of passengers.

Rule 12.12 Blow-off Valves and Piping

(a) The blow-off valve of a digester shall be arranged so as to be operated from protected points, remote from valves.

(b) Through bolts instead of cap bolts shall be used on all digester piping.

(c) Corrosion resisting pipe, valves, and fittings of adequate thickness and size shall be used between the digester and blow pit and these valves, fittings, and pipe shall be inspected monthly.

Rule 12.13 Blow Pits

(a) Blow pit openings shall preferably be on the side of the pit instead of the top. Where located on top, openings shall be as small as possible and shall be provided with railings. (See Section 1, A.S.A. Standard A12.)

(b) A specially constructed ladder shall be used for access to blow pits, to be constructed so that the door of the blow pit cannot be closed when the ladder is in place, or other means shall be provided to prevent the closing of the pit door when anyone is in the pit.

(c) A system of bells or other signalling device shall be installed in the digester and blow pit rooms and chip bins to be operated as a warning before and while digesters are being blown.

(d) Blow pit hoops shall be inspected regularly for defects.

Rule 12.14 Blowing Digester

(a) Blow-off valves shall be opened slowly.

(b) After digester has started to be blown, the blow-off valve shall be left open and the hand plate shall not be removed until the digester cook notifies the blow pit man that blow is completed.

(c) Before starting to load a digester with chips, the cook shall warn the men in the chip bin.

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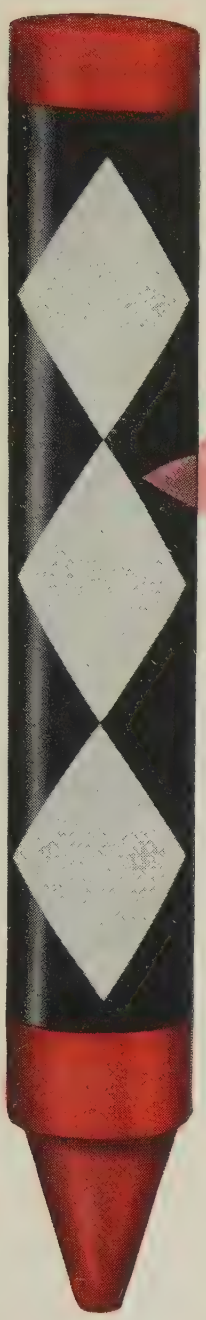

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Rule 12.15 Inspecting and Repairing Digesters

(a) Valves controlling lines leading into a digester shall be locked in the closed position and the keys to the locks shall be in the possession of the person doing the inspecting or making repairs; or these controlling lines shall be disconnected (or blanked off).

(b) Fresh air shall be blown into a digester constantly while workmen are inside.

(c) An inspector shall never enter a digester unless a life line is securely fastened to his body by means of a safety belt, and at least one other experienced employee stationed outside the digester handling the line to summon assistance. All ladders and life lines shall be inspected before each use.

(d) Every precaution shall be taken to safeguard employees against lead poisoning. (See Section 1, A.S.A. Standard Z37.11.)

(e) All employees entering digesters for inspection or repair work shall be provided with protective headgear. Eye protection and dust masks shall be provided workmen while the old lining is being removed.

Rule 12.16 Pressure Tanks—Accumulators (Acid)

(a) Safety regulations governing inspection and repairing of pressure tanks—accumulators (acid) shall be the same as for the digester.

(b) The pressure tanks—accumulators shall be inspected twice annually.

Rule 12.17 Pressure Vessels—Safety Devices

(a) A safety valve shall be installed in a separate line from each pressure vessel; no hand valve shall be installed between this safety valve and the pressure vessel. (See A.S.M.E. Code for unfired pressure vessels.)

(b) All safety devices shall conform to paragraph U-2 in the A.S.M.E. Code for unfired pressure vessels 1946, Section VIII.

Section 13—Sulphate and Soda Processes

Rule 13.1 Miscellaneous

Insofar as the processes of the sulphate and soda operations are similar to those of the sulphite processes, the same Standard rules shall govern.

(a) Quick operating showers, bubblers, etc. shall be available as treatment for caustic soda burns.

(b) Rotary-tenders, firemen, and those cleaning smelt spouts, shall be provided with eye protection (fitted with lenses that filter out the harmful rays emanating from the light source), when actively engaged in their duties.

(c) Blow pipes and water lines shall be inspected periodically for defects.

(d) Smelting tanks shall be covered and closed, except when taking samples.

(e) Vent stacks of ample size shall be provided for exit of gases.

Rule 13.2 Blow Lines

(a) Each digester should have two independent "gas-off" lines and a reducing valve in the high-pressure steam line with safety valve between the digester and the reducing valve.

Note: Two gas-off lines are recommended, so if one plugs with pulp the other may be used and the hazard of unplugging with the digester under pressure overcome.

With the installation of a reducing valve and a safety valve, it will be improbable that pressure will exceed the maximum allowable working pressure of the digester.

(b) Where the blow-off lines from several digesters lead into one pipe, the handles of all cocks should be set uniformly, or some equivalent arrangement should be provided so that a man can see at a glance whether all cocks are set right or not. If valves instead of cocks are provided, a type with rising spindle should be used.

Rule 13.3 Furnace Room

Adequate exhaust ventilation shall be provided where niter cake is fed into a rotary furnace and shall be so designed and maintained as to keep the concentration of hydrogen sulphide gas below 0.002% by volume. (See Section 1, A.S.A. Standard Z37.2.)

Rule 13.4 Causticizing Tanks

Niter cake should never be added to the smelt dissolving in the tanks.

PART V. BLEACHING

Section 14—Bleaching Equipment and Chlorine

Rule 14.1 Bleaching Engines

Bleaching engines, except the Bellmer type, should be completely covered on the top, with the exception of one small opening large enough to allow filling but too small to admit a man. This opening should be covered by a sliding door and guarded with standard guard rail and toe boards. Platforms leading from one engine to another shall have standard guard rails. (See Section 1, A.S.A. Standard A12.)

Rule 14.2 Bleach Mixing Rooms

(a) The room in which the bleach powder is mixed shall be provided with adequate exhaust ventilation, located at the floor level. (See Section 1, A.S.A. Standard Z9.)

(b) The exhaust for removing the chlorine gas shall be carried away from the work place and breathing area of the workers and shall be rendered neutral or harmless before being discharged into the atmosphere.

(c) Suitable gas masks shall be provided for emergency use.

Rule 14.3 Liquid Chlorine

(a) Storage Tanks. Tanks of liquid chlorine shall be stored in a well ventilated unoccupied room, where its possible leakage cannot affect workers.

(b) Neutralization. The preparation of the bleaching mixture with liquid chlorine should be carried out in a room entirely apart from the general workroom. The container for chlorine and its pipe connections should be enclosed in a separate chamber (glass paneled) supplied with a ventilating flue and a fan. Where this is impossible, an exhaust should be installed at the floor level to extract any leaking chlorine.

(c) Respiratory Protection. Suitable gas masks, capable of absorbing chlorine, shall be supplied, in sufficient numbers, conveniently placed, and regularly inspected, and the workers who may accidentally be exposed to chlorine gas should be instructed in their use.

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(d) Emergency Exits. At least two exits, remote from each other, shall be provided for all rooms where chlorine is stored.

PART VI. MECHANICAL PULP PROCESS

Section 15—Wood Preparation and Grinding

Rule 15.1 Pulp Grinders

(a) Grinders driven by water wheel shall be provided with governors limiting peripheral speed to that recommended by the manufacturer.

(b) Doors of pocket grinders shall be so arranged as to keep them from closing accidentally.

Rule 15.2 Butting Saws

Hood guards shall be provided on butting saws.

Rule 15.3 Floors and Platforms

Floors and platforms shall be kept in safe, nonslip condition. (See Section 1, Rule 1.5.)

(New) *Rule 15.4.* Persons exposed to falling material shall wear eye, head, foot, and shin protection. (See Section 1, Rule 1.4.)

PART VII. STOCK PREPARATION

Section 16—Pulp Shredders and Presses

Rule 16.1 Pulp Shredders

(a) Cutting heads shall be completely enclosed except for opening at feed side sufficient only to permit entry of stock. Enclosure shall be bolted or locked in place. Enclosure shall be of solid material or with mesh or other openings not exceeding $^1/_2$ in.

(b) A slanting feed table with outer edge not less than 36 in. from cutting head, or an automatic feeding device shall be provided.

(c) Repairs for clearing of blockage shall be done only when shredder is shut down and control devices locked.

(d) All power-driving mechanisms shall be guarded in accordance with Section 1, Rule 1.3.

Rule 16.2 Pulp Conveyors

Pulp conveyors and conveyor drive belts and pulleys shall be fully enclosed or if open and within 7 ft. of floor, shall be constructed and guarded in accordance with Section 1, A.S.A. Standard B20.1.

Section 17—Beaters and Washers

Rule 17.1 Floors, Steps, and Platforms

Floors, steps, and platforms shall be kept in nonslip condition. (Section 1, Rule 1.5.)

Rule 17.2 Beaters

(a) Beater rolls shall be provided with substantial covers.

(b) Guard rails 42 in. high shall be provided around beaters where tub tops are less than 42 in. from floor. (See Section 1, A.S.A., Standard A12.)

(c) When cleaning, inspection, or other work requires that persons enter the beaters, all control devices shall be positively locked in off or closed position.

(d) When beaters are fed from floor above, the chute opening if less than 42 in. from the floor, shall be provided with a complete railed or other enclosure. Openings for manual feeding shall be sufficient only for entry of stock and shall be provided with at least two permanently secured cross rails.

(e) When beaters are fed manually from floor above conveniently located emergency stop devices should be provided at the top level.

Rule 17.3 Hydropulpers

(a) All hydropulpers having the top or any other opening of vessel less than 42 in. from the floor or work platform, shall have such openings guarded by railed or other enclosures. For manual charging, openings shall be sufficient only to permit the entry of stock and shall be provided with at least two permanently secured cross rails. (See Section 1, A.S.A. Standard A12.)

(b) When cleaning, inspecting, or other work requires that persons must enter the hydropulpers, one person shall be stationed outside in a position to observe and assist in case of emergency.

(c) When cleaning, inspection, or other work requires that persons enter hydropulpers all steam, water, or other control devices shall be positively locked in closed or off position. Blank flanging of pipe lines is acceptable in lieu of closed and locked valves.

Blank flanging of steam and water lines shall be acceptable in lieu of valve locks.

(d) All power mechanisms shall be adequately guarded. (See Section 1, A.S.A. Standard B15.1.)

Rule 17.4 Stock Chests

(a) All control devices shall be positively locked in off or closed position when persons enter stock chests.

(b) All power mechanisms shall be adequately guarded. (See Section 1.)

PART VIII. MACHINE ROOM

Section 18—General

Rule 18.1 Emergency Stops

Paper machines shall be equipped with devices that will stop the machines quickly in an emergency. The devices shall consist of push buttons for electric motive power or electrically operated engine stops, pull cords connected direct to the prime mover, control clutches, etc., and interlocked with adequate braking action. The devices shall be tested frequently by making use of them when stopping the machine and shall be so located that any person working on the machine can quickly disconnect the machine from the source of power in case of emergency.

Rule 18.2 Clothing

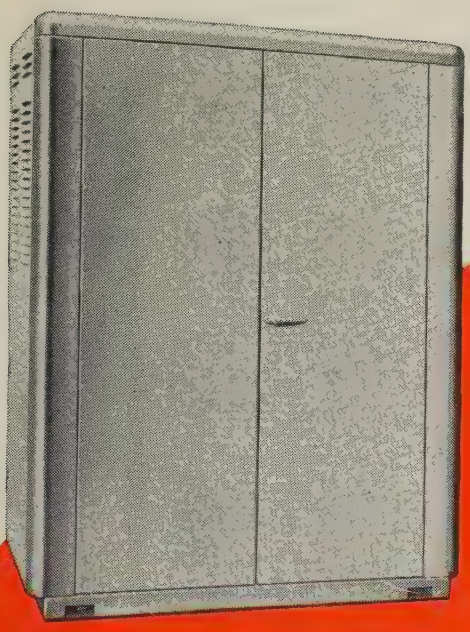
Employees in this department should wear safety toe shoes at all times. Employees in this department should not wear loose clothing.

Rule 18.3 Drives

Drives on equipment requiring service while operating shall have standard guards. (See Section 1.) Lineshaft drives shall have pulleys and couplings guarded unless the whole lineshaft is isolated by use of continuous guard rails.

Rule 18.4 Protective Equipment

Face shields, aprons, and rubber gloves shall be provided for workmen handling acids.



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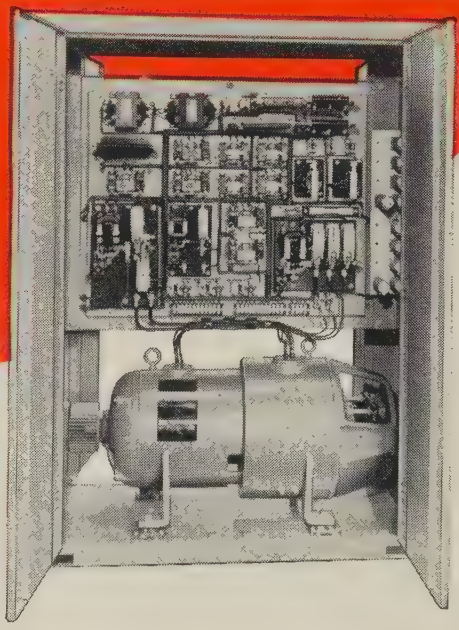

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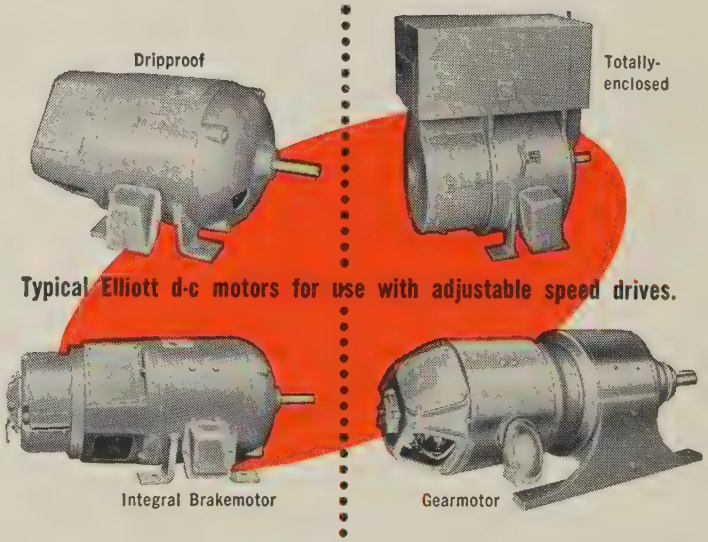

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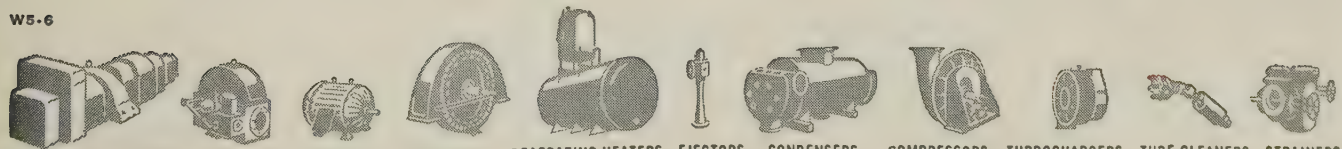

Rule 18.5 Walkways

Steps and footwalks along the fourdrinier should have nonslip surfacing and be complete with standard handrails, when practical. (See Section 1, Rule 1.5.)

Section 19—Presses and Driers

Rule 19.1 Steps

Suitable steps of uniform rise and tread and with nonslip surfaces shall be provided at each press.

Rule 19.2 Plank Walkways

A removable plank of sufficient width shall be provided along each press, with standard guardrails installed wherever practical; the plank to have a nonslip surface. (See Section 1, Rule 1.5.)

Rule 19.3 Drier Lubrication

If gear bearings must be oiled while machine is in operation, an automatic oiling device or other equally efficient means to protect the oiler should be provided.

Rule 19.4 Levers

All levers carrying weights shall be constructed so that weights will not slip or fall off.

Rule 19.5 First Drier

Either a permanent guard rail or apron guard or both shall be installed in front of the first drier in each section.

Rule 19.6 Steam and Hot-Water Pipes

All steam and hot-water pipes within 7 ft. of the floor or working platform, that are exposed to contact, shall be covered with an insulating material, or guarded in such manner as to prevent contact.

Rule 19.7 Drier Gear Guards

Drier gear guards shall adequately cover the gear contact points.

Rule 19.8 Broke Hole

A handrail shall be provided at the broke hole at the last bottom drier. (See Section 1, A.S.A. Standard A12.)

Section 20—Calender Stack

Rule 20.1 Feeder Belt

A feeder belt or other efficient device should be provided for starting paper through a calender stack, where practical.

SUBCOMMITTEE ON MACHINE ROOM

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Harry J. Hahn
Hammermill Paper Co.
Erie, Pa.

Otto Wagers
The Champion Paper & Fibre Co.
Houston, Tex.

H. B. Goodrich
Strathmore Paper Co.
West Springfield, Mass.

Eddie Page
Kimberly-Clark Corp.
Neenah, Wis.

Oscar Nelson
The State of Wisconsin Industrial Commission
Madison, Wis.

John Byrne
The Paraffine Co.
Emeryville, Calif.

Myron Ross
Marathon Corp.
Menominee, Mich.

L. G. Murray
Pond Extract Co.
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Forrest Kimmel
Sutherland Paper Co.
Kalamazoo, Mich.

Robert W. Gray
Union Bag & Paper Corp.
Savannah, Ga.

Kenneth L. Faist
The Champion Paper & Fibre Co.
Hamilton, Ohio

H. K. Lambie
The Paraffine Co.
Emeryville, Calif.

Francis Wagner
The Mead Corp.
Chillicothe, Ohio

Rule 20.2 Steps

Suitable steps or ladders of uniform rise and tread and with nonslip surfaces and handrails or hand grips shall be provided at each calender stack.

Rule 20.3 Grounding

All calender stacks and spreader bars shall be adequately grounded as protection against shock induced by static electricity.

Rule 20.4 Sole Plates

All exposed sole plates between driers, calenders, reels, and rewinders shall be coated with a nonskid paint or some type of nonskid surface.

Rule 20.5 Nip Points

The hazard of the nip points on all calender rolls should be eliminated or minimized by means of, (1) angle iron, pipe, or other equally efficient barrier device or (2) by feeding the paper into the rolls by means of a rope carrier, air jets, or (3) use of hand feeding device.

Rule 20.6 Platforms

A suitable nonslip walkway and standard handrail should be provided on both sides of the stacks.

A suitable platform should also be provided at the top of the stack for the protection of workmen when changing calender rolls. (See Section 1, A.S.A. Standard A12.)

Rule 20.7 Levers

All levers carrying weights shall be so constructed that weights will not slip or fall off.

Rule 20.8 Doctors

Each roll on all machine calenders shall be equipped with an efficient doctor.

Rule 20.9 Broke Hole

Suitable protection should be provided around the broke hole between the calender and the reel. (See Section 1, A.S.A. Standard A12.)

Section 21—Winding Reels

Rule 21.1 Space Between Reels

On stack reels, a clearance of at least 8 in. between the reels of paper shall be maintained by means of an 8-in. wheel between the reels, or a stop below the bottom reel and above the top reel, or other equally efficient device.

Rule 21.2 Reel Brakes

Full reels should not be removed from the drum by crane or hoist while still revolving.

Rule 21.3 Feeder Belts

Feeder belts, carrier ropes, or air carriage shall be provided for starting paper into the nip on reel-type drums.

Section 22—Rewinders

Rule 22.1 Inrunning Nip

The nipping point of all drum winders and rewinders

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where the roll runs in on the operator's side should be guarded by either automatic or manually operated barrier guards.

Rule 22.2 Core Collars

Set screws for securing core collars to winding and unwinding shafts shall not protrude above the face of the collar.

Rule 22.3 Slitter Knives

Slitter knives shall be protected underneath by the use of a sheet metal guard and above by individual metal guards.

Rule 22.4 Winder Shaft

In order to avoid the use of ropes all shafts should be equipped with a winder collar guide.

Rule 22.5 Core Shaft

When the core shaft weighs in excess of 100 lb. a suitable mechanical device, such as a dolly, shall be provided for carrying all or part of the weight when it is being removed from the set of paper and placed in the dressing brackets on the winder.

PART IX. FINISHING ROOM

Section 23—Supercalender

Rule 23.1 Supercalender Guards

Guards shall be provided for supercalenders where practical for all inrunning nips.

Rule 23.2 Scrubbing Blocks

Rotating wheels or wooden blocks faced with emery cloth or sandpaper shall be used for scrubbing supercalender rolls. Rolls shall be cleaned only on the outrunning side.

Rule 23.3 Emergency Stops

Electrically or manually operated quick power-disconnecting devices, interlocked with adequate braking action, shall be provided on all operating sides of the machine, within easy reach of all employees. These devices shall be tested frequently by making use of them when stopping the machine.

Rule 23.4 Core Collars

Set screws for securing core collars to winding and unwinding shafts shall not protrude above the face of the collar.

SUBCOMMITTEE ON FINISHING ROOM

Chairman: John H. Selden

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Safety Engineer
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Milford, N. J.

Russell Bell
Director of Safety
Crossett Paper Mills
Crossett, Ark.

D. V. Hill
Safety Director
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Chester, Pa.

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R. M. Gilmore
General Safety Supvr.
Rayonier, Inc.
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Dallas E. Henry
Safety Coordinator
Southern Advance Bag & Paper Co.
Hodge, La.

Harley B. Goodrich
Safety Engineer
Strathmore Paper Co.
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Roy Faulkner
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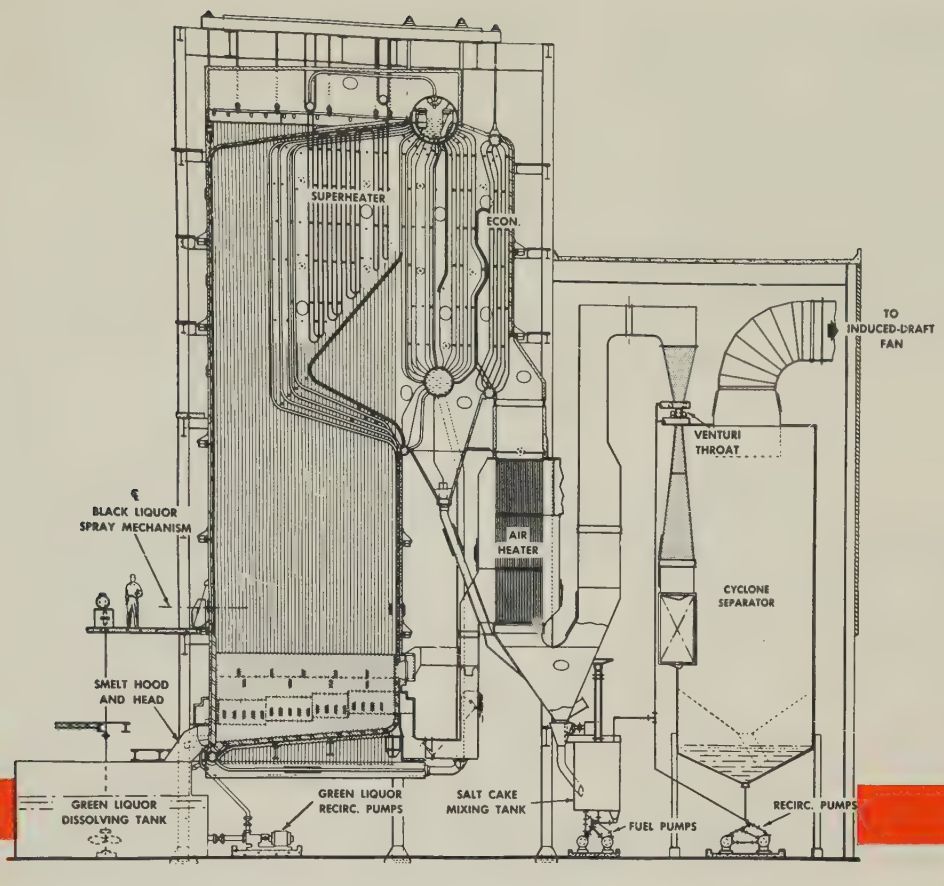

Venturi Evaporator-Scrubber

(Contact Liquor Evaporator) (Fume Collector)

Installed with B&W Recovery Unit at THILCO P&P COMPANY PRODUCTS means Improved Economy

The Babcock & Wilcox Company black-liquor recovery system illustrated above has completed two years of continuous trouble-free operation at THILMANY.

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Section 24—Cutting and Trimming Machinery

Rule 24.1 Guillotine-Type Cutters

(a) Only persons who are authorized to do so shall operate cutting and trimming machinery.

(b) Each guillotine-type cutter shall be equipped with a control which requires the operator and his helper, if any, to use both hands to engage the clutch.

(c) Each guillotine-type cutter shall be equipped with a nonrepeat device.

(d) Suitable carriers shall be provided for transportation of knives of guillotine-type cutters.

Rule 24.2 Rotary Cutter

(a) On single knife machines a guard shall be provided to prevent employees reaching for paper at a point close to the knife.

(b) On duplex cutters the same protection shall be provided as for single knife machines for the first knife and a hood shall be provided for the second knife.

(c) Safe access shall be provided to the knives of rotary cutter by means of cat walks with nonslip material, railings, and toe boards. (See Rules 1.1 and 1.5.)

(d) A guard shall be provided for the spreader or squeeze roll at the nip side on sheet cutters.

(e) Electrically or manually operated quick power-disconnecting devices with adequate braking action shall be provided on all operating sides of the machine within easy reach of all operators.

(f) Where slitters are used, at least the outside slitters shall be guarded.

Section 25—Platers

Rule 25.1 Machine Guards

(a) Guard shall be arranged across the face of the rolls to serve as a warning so that the operator's hand may not be crushed when feeding the machine.

(b) A quick power-disconnecting device shall be installed on each machine within easy reach of the operator's hand.

Section 26—Rewinders

Rule 26.1 Rewinders

(a) A movable barrier shall be provided in front of the roll of paper to prevent an employee getting caught at the nip point. This barrier shall be interlocked with the drive mechanism so that the machine cannot be started unless the barrier is in operating position. (See Rule 22.1.)

(b) Nonslip surface shall be provided in front of the rewinder to prevent an employee from slipping. (See Rule 1.5.)

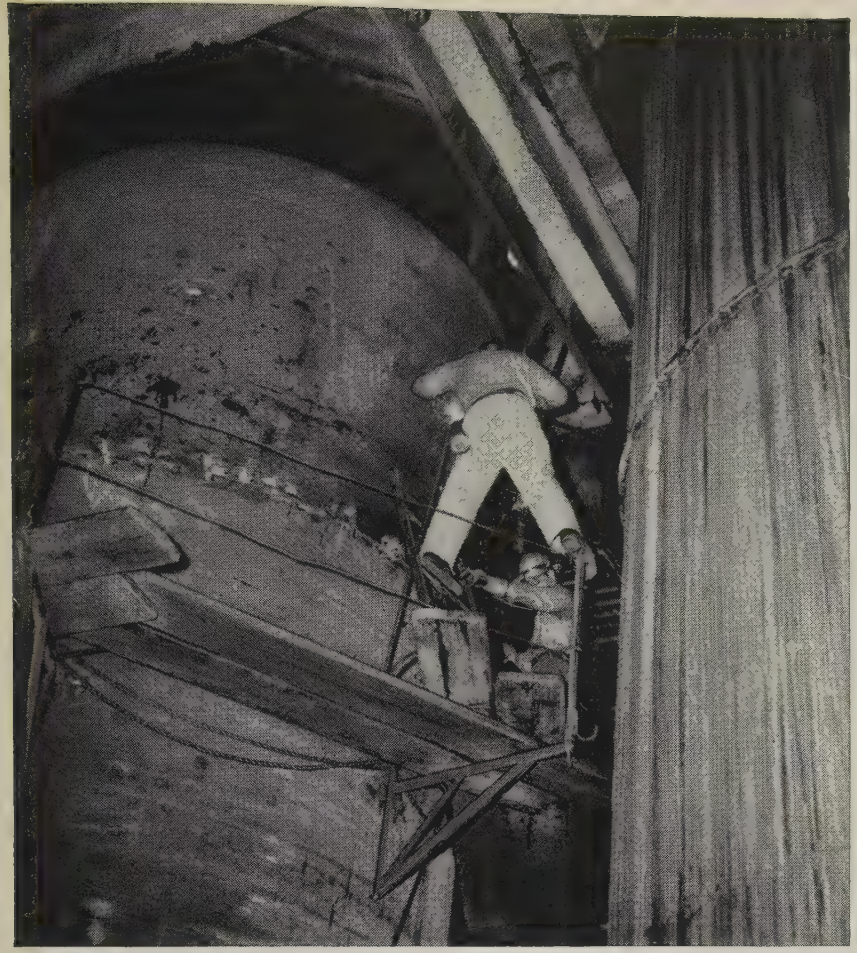
(c) A container shall be provided for all tools such as hammers, wedges, collars, etc., so that they may be kept off the floor.

(d) Adequate mechanical lifting devices shall be provided for placing and removing rolls from the machine.

Section 27—Embossers

Rule 27.1 Roll-Type Embosser

(a) A nip-guard shall be placed on the inrunning side of embossing rolls.



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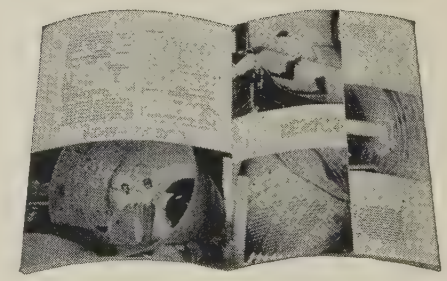

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Rule 27.2 Embosser—Platen-Type

(a) A guard shall be provided on the operating and take-off side of hand-fed platen-type embossers which shall be interlocked with the driving mechanism so that the machine cannot be operated unless the guard is in position.

Section 28—Sorting and Counting Tables

Rule 28.1 Tables

(a) Table shall be smooth and free from splinters with edges and corners rounded.

(b) Paddles shall be smooth and free from splinters.

Section 29—Power Trucks

Rule 29 Power Trucks

(a) No person shall ride on walking-type power-driven trucks. Where operator is furnished a riding platform or seat, only the operator shall ride in the operating position. Unauthorized passengers shall not be permitted to ride on industrial power-driven trucks.

(b) Power trucks controlled by an operator who stands and the pedals project at the rear shall be equipped with a bumper behind the control pedals.

(c) If piling is done above the head of the operator, a guard shall be provided to prevent materials falling on operator.

(d) Power trucks shall be equipped with governors to prevent excessive rates of speed.

(e) Where gasoline-powered trucks are operated indoors, ventilation or other control devices shall be used to maintain carbon dioxide at safe limit (Z37.1 American Standards Code).

(f) Power trucks shall be equipped with a warning device which can be heard above the noise of the mill.

(g) An inspection schedule shall be maintained to make sure that all parts of the trucks are in good operating condition at all times.

(h) Operation and maintenance of power trucks shall conform to Code B56.1.

(i) Rear vision mirrors should be provided for fork lift trucks.

Section 30—Hand Trucks

Rule 30 Hand Trucks

(a) There shall be no riders on hand trucks.

(b) Hydraulic devices on hand lift trucks shall be regularly inspected and maintained in good operating condition at all times.

Section 31—Pallets and Skids

Rule 31 Pallets and Skids

(a) Pallets and skids shall be kept in good repair.

(b) Pallets and skids shall not be stored on edge.

(c) Skids should be piled, one up and one down, to prevent sliding during transportation.

Section 32—Cartons

Rule 32 Cartons

(a) The head of the carton stitching machine shall be guarded so that operator's fingers will not be caught.

(b) Floor around the machine should be kept clean and free of staples.

(c) Paste shall be kept in the containers and if spilled onto the floor shall be promptly removed. (See Rule 1.5.)

Section 33—Skid Banding

Rule 33 Banding of Skids, Cartons, Cases, etc.

(a) Banders and helpers shall wear eye protection. (See Rule 1.4.)

(b) If gloves are worn, they shall be of a type from which the hand can be quickly freed.

(c) Boxes, cartons, or packages shall not be handled by the steel bands or wires.

Section 34—Loading Trucks or Cars

Rule 34 Loading cars or trucks

(a) Loading platforms shall be kept clean. (See Rule 1.5.)

(b) Where steel bands, or wires, are used in box cars or trucks, all loaders and helpers shall wear eye protection. (See Rule 1.4.)

(c) The construction and use of bridge or dock plates shall conform to the requirements of A.S.A. Code B56.1. (See Section 1.) Plates shall be stored so as not to become a tripping or falling hazard.

(d) When closing the car door, employees should push, never attempt to pull it. Mechanical means of closing car doors should be provided.

(e) Flag signals, derails, or other protective devices shall be used to protect men during switching operations.

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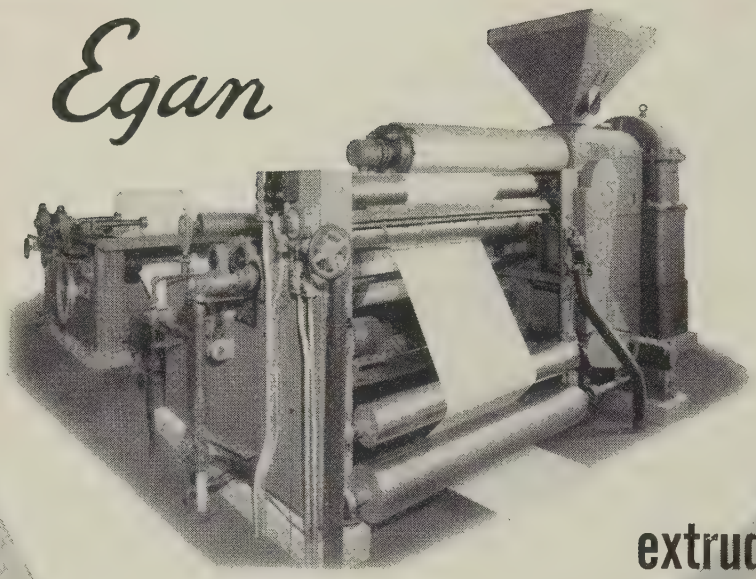

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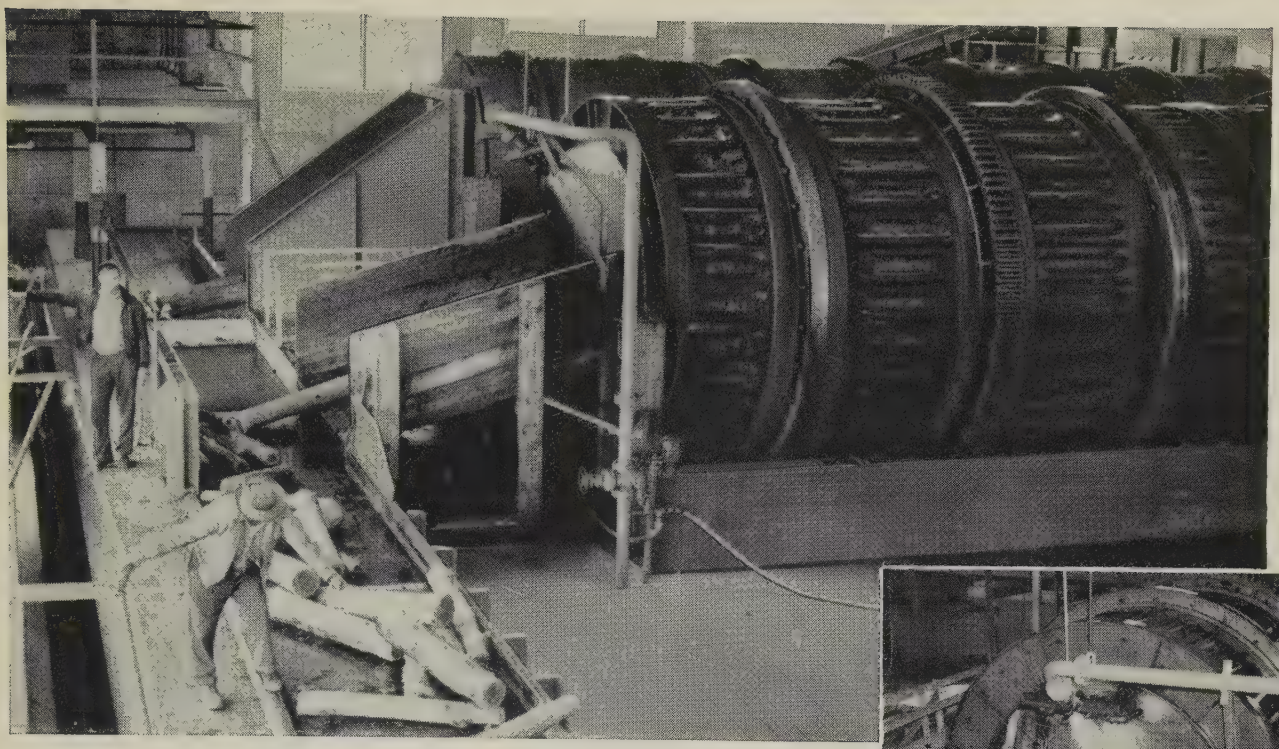

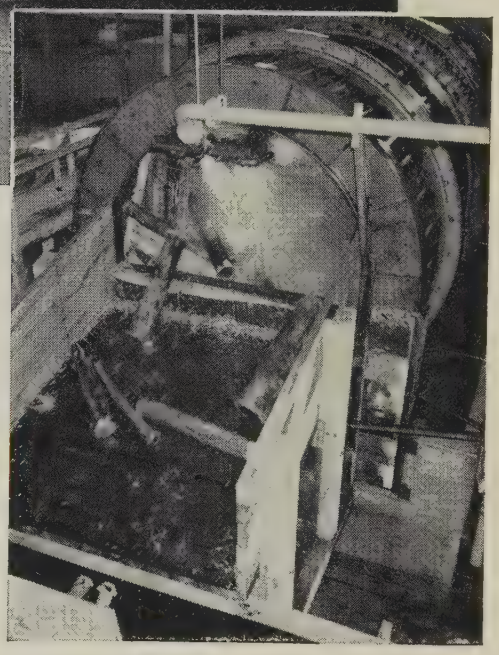

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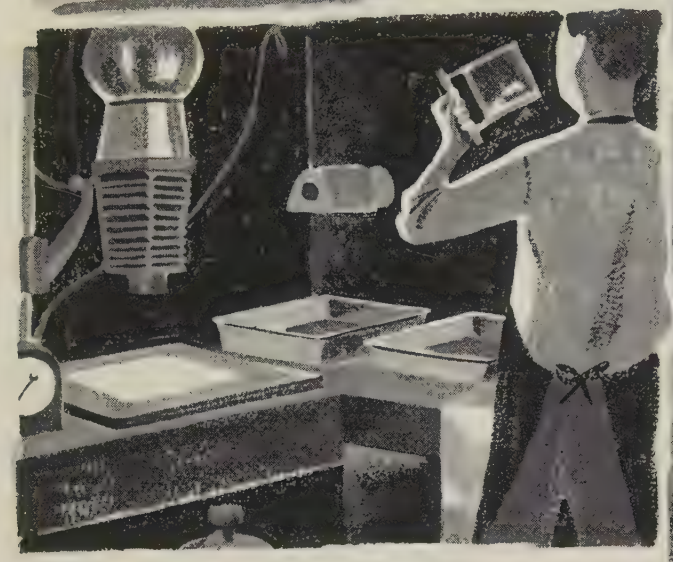

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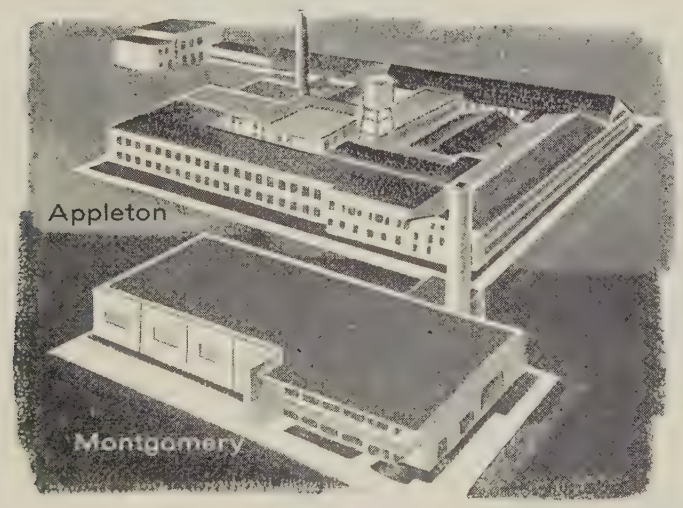

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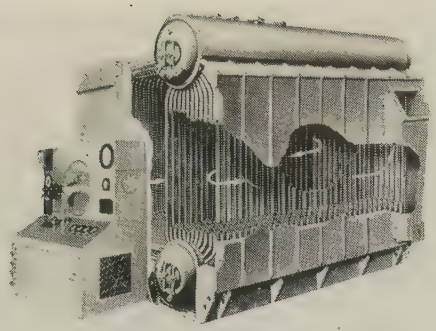
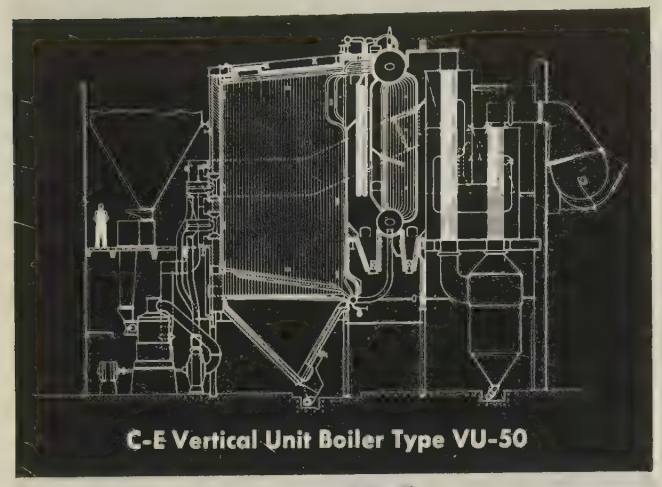
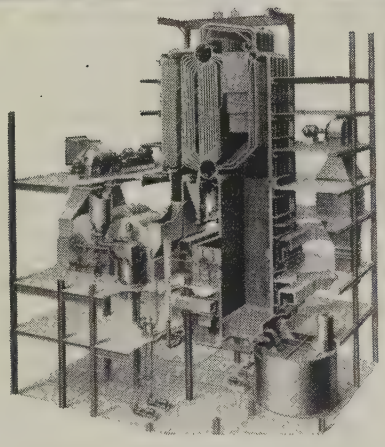


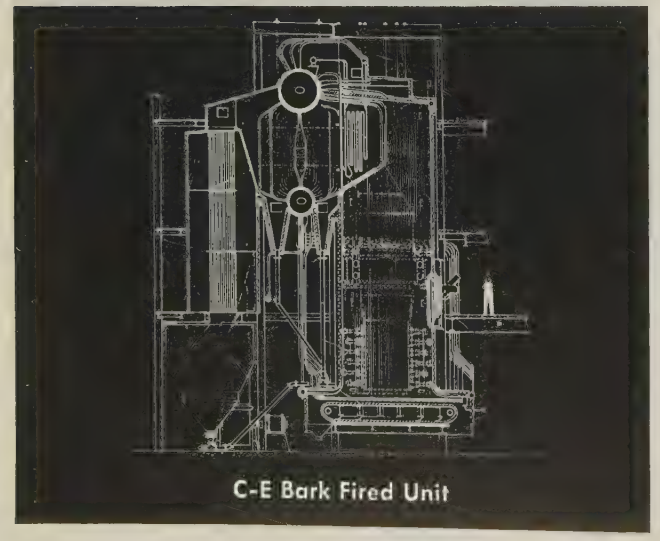
C-E Package Boiler



C-E Vertical Unit Boiler Type VU-50



C-E Recovery Unit



C-E Bark Fired Unit

Got a Steam or Fuel Burning Problem?...

See C-E!

Package boiler, power boiler or chemical recovery unit—if your problem concerns how best to burn fuel to generate steam efficiently, reliably and economically—See C-E.

Why? Because C-E has a complete line of steam generating and fuel burning equipment both standardized and custom-made to fit all the specialized requirements of the pulp and paper industry. No matter whether you burn Black Liquor, Waste Sulfite Liquor, Bark, Hogged Wood, Coal, Oil or Gas, C-E offers you equipment *designed specifically* for each job.

The acceptance accorded C-E equipment by the Pulp and Paper Industry is evidenced by the following facts.

1. Since 1945, leading pulp and paper mills have purchased C-E power boilers having an aggregate capacity of more than 11,000,000 lb of steam per hour.

2. Since 1945, thirteen leading mills have reordered C-E power boilers. In fact, one internationally known paper company placed *seven separate orders.*

3. Since 1945, more than 80 C-E Chemical Recovery Units have been purchased by pulp mills throughout the world. These include units ranging in capacity from less than 100 tons to the world's largest, having a capacity in excess of 500 tons.

4. Since 1945, eighteen leading pulp mills have *reordered* C-E Recovery Units; of this number four mills have reordered twice and one mill three times.

5. The C-E Bark Burning System, the recent C-E development that has revolutionized bark and hogged wood burning, has already been installed in a score of pulp mills at home and abroad. Performance records show greatly increased efficiency and substantial savings over old fashioned bark burning methods.

These are but five indications of the widespread acceptance of C-E equipment in the pulp and paper industry. They are five good reasons why, before you buy, you should See C-E.

B-850

COMBUSTION ENGINEERING

C-E

Combustion Engineering Building

200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

How stainless steel cuts operating costs

in everything from . . .

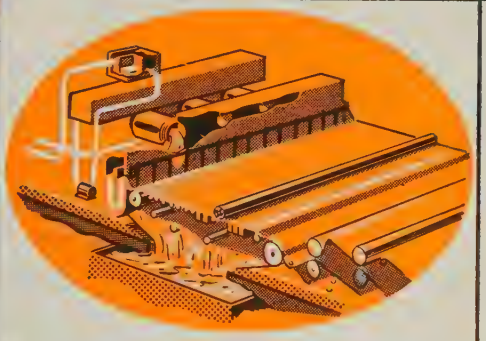
. . . chips and groundwood processing . . .

Corrosion resistance and chemical inertness of stainless mean cleanliness and freedom from iron pickup. Hoppers, hoods and stock lines last longer, need little cleaning, show exceptional stock flow characteristics.

. . . to sulphite pulping . . .

Here, by corrosion resistance alone, stainless quickly pays for itself. Cuts costs still further by adding strength and wear resistance to everything from blow-pit target plates to false bottom screens . . . digester circulating systems to heat exchangers.

. . . to the paper machine itself!



Strength, cleanability, corrosion resistance of stainless help cut slime, cleaning time and maintenance. Stainless screens, for example, are corrosion resistant . . . free from contamination . . . long lasting — with clean, accurate perforations and fast filtering characteristics.

Whatever process you're concerned with, you can be sure the *right* stainless type will go a long way to cut your operating costs, boost production, increase product quality. Your Crucible representative will gladly help you in the selection, application and fabrication of stainless steel. Ask him for a complimentary copy of "Making the Most of Stainless Steel in the Pulp and Paper Industry." Or write to *Crucible Steel Company of America, Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Many of the popular magazines on American newsstands are made economically possible, in large part, by "Virginia" Zinc Hydro.

"VIRGINIA" ZINC HYDRO

Produces Bright Pulp at Low Cost

Brand new techniques for the reduction-bleaching of groundwood pulp with "Virginia" Zinc Hydro are piling up profits for pulp mills.

This powerful reducing agent does a comparable job at about one-half the cost of oxidizing bleaches.

Here are some of the actual results recently reported:

- "A 12-point brightness increase."
- "Per ton costs have never exceeded 60c per brightness-point."
- "We have saved as much as $8 per ton."
- "Brightness permanence is equal to other bleaching."

The "Virginia" Zinc Hydro process with its economies in time and efficiency applies to the big and little mill alike. Almost no new equipment investment is needed; fewer chemical additives are required. Chemically, "Virginia" Zinc Hydro is stable in storage. It is free-flowing, non-clogging and non-corrosive.

A competent, experienced Virginia engineer will be glad to discuss these new developments at your plant—just tell us when you'd like to have him come. **Industrial Department, Virginia Smelting Company, Dept. 77-P, West Norfolk, Virginia.**

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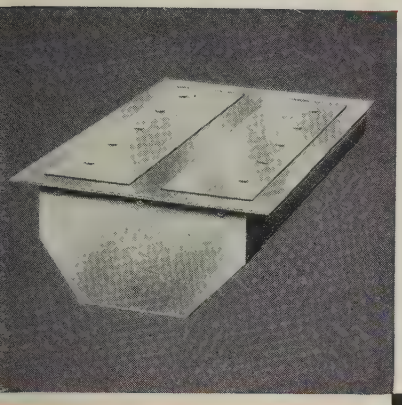
Available in Canada and many other countries

GR-R-R! WHAM! BANG! SMASH!

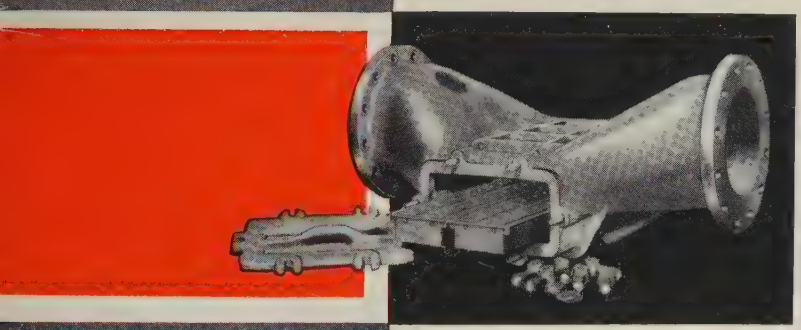
RESULT: Costly machinery repairs and shutdowns.

PREVENTION: Emerson Permanent Magnetic Separation Equipment prevents work stoppages and damage to your vital machines with the proper equipment to remove foreign materials from all stock conveying systems.



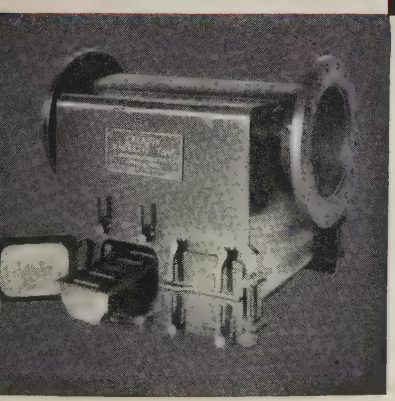
EMERSON PERMANENT MAGNETIC PLATES

Adaptable for a wide variety of independent installations in pipes, ducts, lines, flow boxes, head boxes, belts, conveyors, troughs or on machines. Three standard types — for moderate, intermediate and extreme junk metal separation requirements. All magnets cast of super-strength Hyflux Alnico V, and completely enclosed in plate housing of non-magnetic stainless steel.



EMERSON MAGNETIC SEPARATORS

Designed for stock line installation for all moderate separation requirements. All stock is directed to the magnetic field at an angle and retained before continuing, with no restriction to the flow. Tramp metal is collected on the plates for easy, periodic cleaning.



EMERSON MAGNETIC TRAPS

The latest development in separation techniques. For stock line removal of both ferrous and non-ferrous metals under conditions of high stock velocity and consistency. The entire stock flow is carried to the flux pattern of heavy duty magnets at right angles to the face and is trapped, for junk material separation, before rising above the retaining baffle to continue with no flow restriction.

Write for fully descriptive, illustrated Catalog No. M-554

The Emerson Manufacturing Co.

Division of John W. BOLTON & Sons, Inc.

Lawrence, Massachusetts, U. S. A.

Chief SANDUSKY

With an accent on Small Parts that Play a Big Part

We'll grant you that the performance of a shower pipe isn't going to make or break your paper mill, but it can surely play an important part in getting smoother production. That's why Chief Sandusky should be your first choice in the selection of your showers.

Sandusky is the shower that's non-clogging. A simple push-pull of the locking "D" rod handle and the cleaner valve and sliding cleaner rings go into action. The moveable spray lip insures a razor sharp curtain of water, and can be repositioned time after time to provide new sheet forming surfaces.

Also important is the flexibility of these showers, which can be assembled and supplied for specific operation on most types of machines and their varied factors of water fibre and chemical content, pressure, disposal methods, etc.

All these comparatively small, but unique, Sandusky features should add up to a big part in your shower selection.

Why not get the facts?

Write today for more detailed and comprehensive information on The Shower Pipe of Features.

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Check PAPER POROSITY and SMOOTHNESS *instantly*

You can now determine *instantly* and accurately the smoothness and porosity of any paper with the Sheffield Smoothness Tester and the Porosimeter.

In addition to an *instantaneous* check, the range and precision are considerably beyond what is specified in TAPPI Standards No. T-479 sm 48 for smoothness—No. 40-M49 for porosity. Many more checks can be made, assuring more uniform quality. And it doesn't take a highly skilled laboratory technician to get accurate results. Readings correlate with those of other instruments.

Both instruments are successfully operating in the paper industry—users' names on request. Both are sold on a money back guarantee of satisfaction.

OTHER ADVANTAGES ARE:

- **A positive system of notation**
- **Can be used in the mill or laboratory**
- **Gages are easily and quickly read**
- **Reading is visible until paper sample is removed**
- **Combines sensitivity and ruggedness**

Write for a demonstration in your plant and for engineering data to Div. 600, **THE SHEFFIELD CORPORATION, Dayton 1, Ohio, U.S.A.**

Porosimeter

Paper Smoothness Tester

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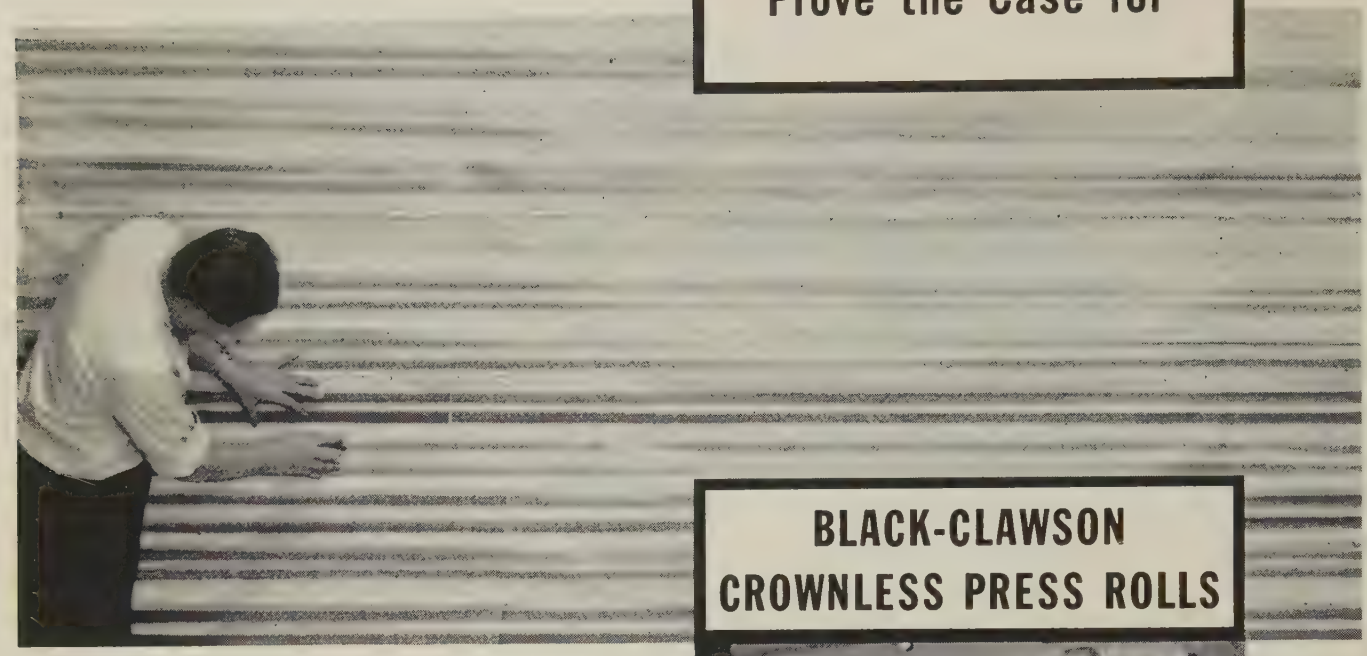
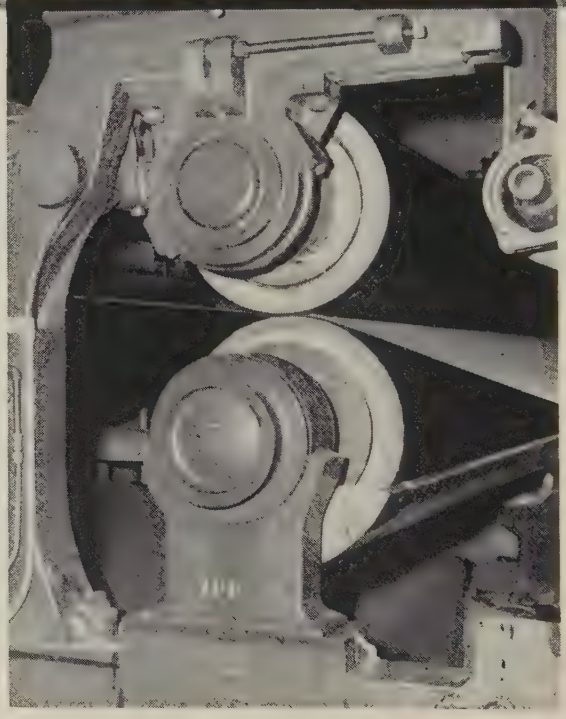
Carbon Paper Tests Prove the Case for



BLACK-CLAWSON CROWNLESS PRESS ROLLS

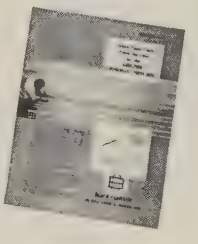


Recent comparative field tests, the results of which are shown above, involved the use of pairs of conventional press rolls and pairs of B-C Crownless Press Rolls. The procedure was to lay carbon paper between two strips of graph paper and set the top roll down at various pressures to make visible nip impressions.

The differences in nip patterns between conventional press rolls and Black-Clawson Crownless Rolls tell an amazing and interesting story—actually prove that only Crownless Press Rolls can give you uniform nip pressure, uniform water removal and uniform felt wear.

Bulletin 8-BC describes these tests and contains comparative nip impression readings, nip patterns, construction details and other advantages of Black-Clawson Crownless Press Rolls.

Write for Bulletin 8-BC today.



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obtain smooth, high gloss, mottle free printing ---- at reduced ink costs with

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When applied on either calender stack or size press as a .75% — 3.5% solution, the following advantages may be expected:

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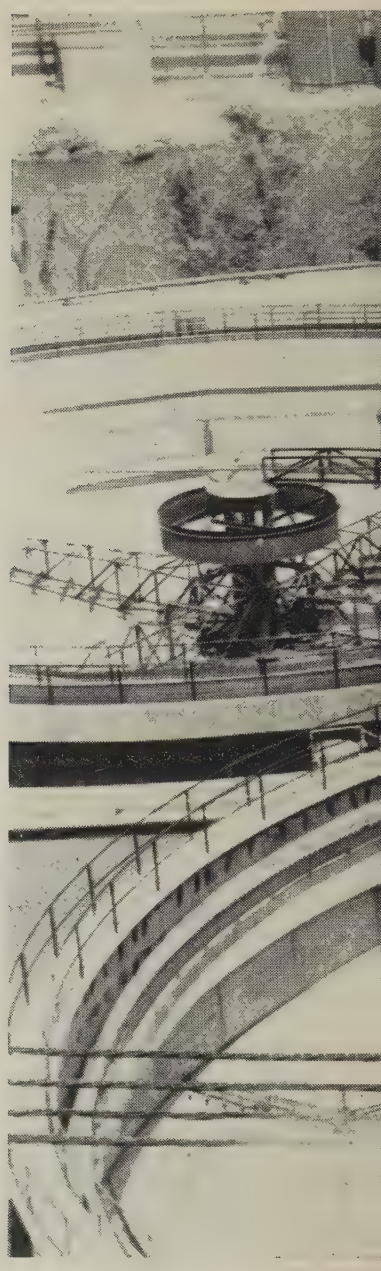


West Virginia Pulp and Paper Company Pioneers New Waste Treatment Process

Dorr-Oliver Equipped Plant Sets Pattern For Industry

Covington, Va. Industrial waste treatment has taken a major step forward with the start-up of this new plant at West Virginia Pulp and Paper Company's Covington, Va., mill. A "first" for the alkaline pulping industry, it points the way toward a solution of these tough-to-handle wastes. Two years of pilot plant work went into the final design and the Covington mill's River Research Group worked closely with the National Council for Stream Improvement throughout all phases of the project. The firm of Weston, Eckenfelder and Hood was also called in to make an intensive round-the-clock analysis of pilot plant results.

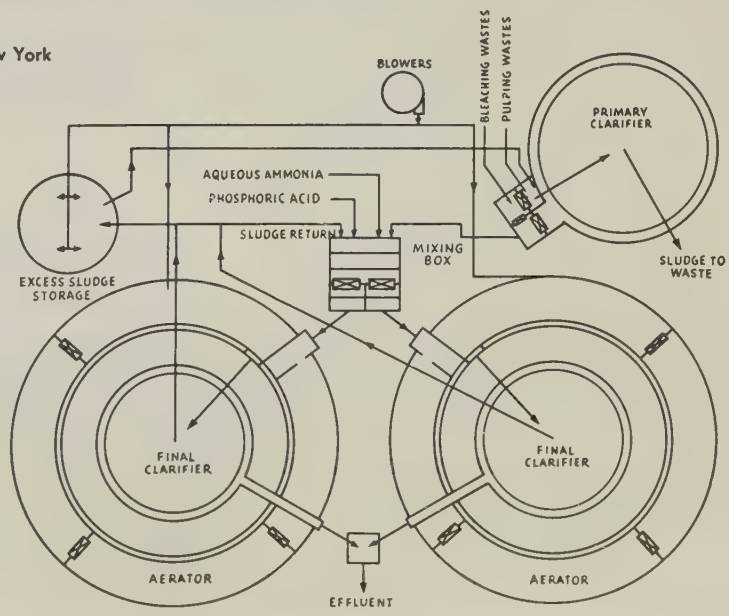
The flowsheet as developed is unique. Basically it employs the activated sludge process, one of the standard methods for treating municipal sewage. A departure from standard practice is the addition of certain nutrients essential to the life of the bacteria which carry out the treatment process. Another is split treatment providing primary sedimentation for the portion of mill wastes containing solids and then parallel aeration and final sedimentation for the entire flow. A third is the use of complete instrumentation with one control panel governing the process and recording results.

Average treatment plant design is 16 MGD with a maximum capacity of 25 MGD. Major

General view of the plant during final stages of construction. Dorr Primary Thickener is in foreground with Currie Claraetors in rear.

Consulting Engineers: GIBBS & HILL, INC., New York, New York

equipment units include a Dorr Primary Thickener and two Currie Claraetors.* These latter units employ Dorr Final Clarifiers surrounded by annular aeration channels. In this way two distinct phases are carried out in a single unit. When the plant reaches full operation an estimated BOD reduction of 80-90% will be made in the mill effluent being discharged to the Jackson River.



Dorr-Oliver Incorporated, Stamford, Conn.

*Trademark, Reg. U. S. Pat. Off.

The superior quality of OK BRAND starches gives you improved tub, beater, and calender sizing. Better for coating and adhesives, too. When you make better paper at no extra cost — you've put more profit in your "paper work". Try OK BRAND and see! Discuss your special starch requirements with Hubinger's expert technicians.

the stamp of quality

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THE HUBINGER COMPANY
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OK BRAND

Try these top-quality starches for paper makers:

- OK BRAND Pearl
- OK BRAND E-Type Pearl
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- OK BRAND Pre-Jel
- OK BRAND Thin Boiling Starch
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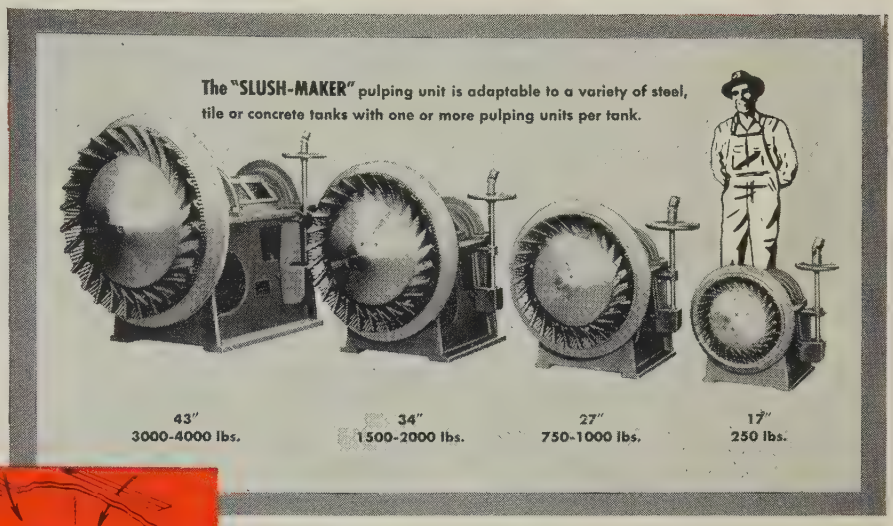
MORDEN SLUSH MAKER®

Patented

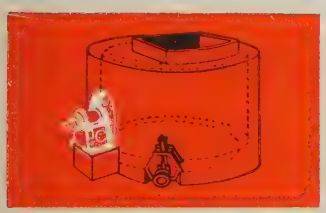
For Pulping

The Morden "Slush-Maker" can be used for either continuous or batch operation. Whichever method is used, there is a rapid defibering.

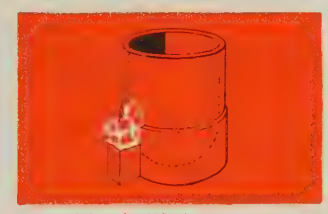


These thumbnail sketches show some of the many tanks that can be designed to suit specific mill requirements.

Dry-End Continuous Broke Pulper with Single Rotor



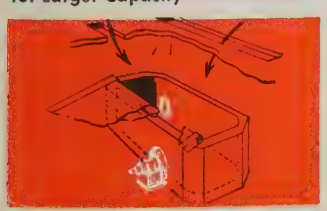
Low-Headroom — Side-Discharge Tank



Special Single-Wall Cylindrical Tile Tank

Standard Double-Rotor Tank for Larger Capacity

Special Cylindrical-Top Steel Tank



Dry-End Continuous Broke Paper Pulper with Double Rotor

Standard Tank with Special Charging Port

Advantages

- **Full Bales or Slabs** can be charged by hand, lift truck or conveyor.
- **Dry-End Broke** can be handled continuously, directly under the paper machine.
- **Wet-Strength Papers** are readily reclaimed with the "Slush-Maker".
- **Rapid Pulping Action** permits greater production per day.
- **Operation** can be batch or continuous.
- **Vigorous Circulation** thoroughly mixes the colors and chemicals in less than a minute.
- **Completely Cleared Stock** reduces amount of beating and jordaning treatment required after pulping.
- **Tramp Materials** will not damage or bind the pulping unit.
- **Side-Mounted Pulping Unit** permits low-headroom applications, simple drives.

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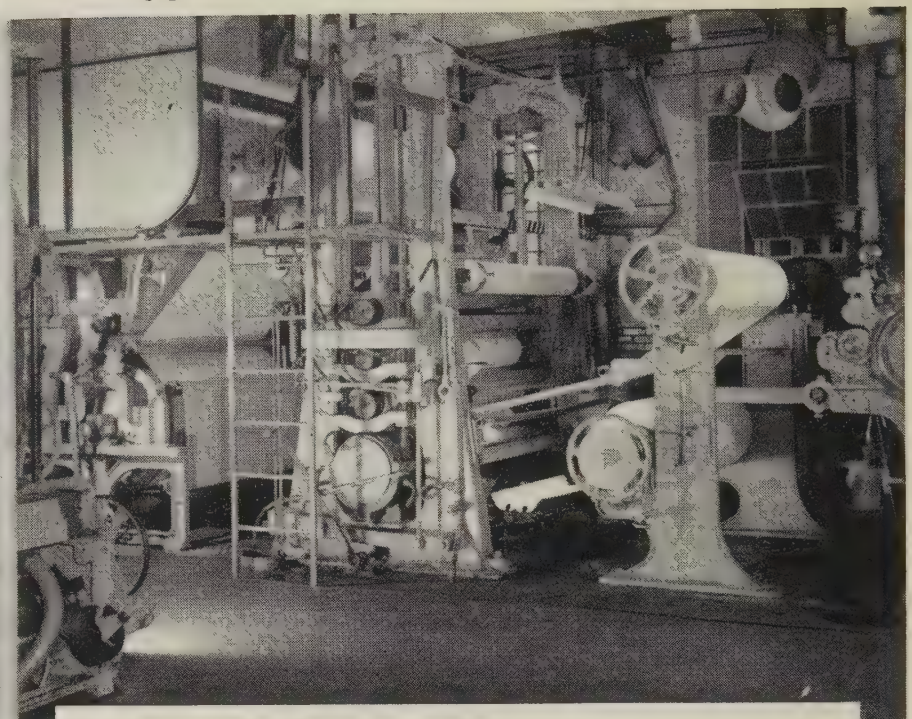
Cut Weight Variation as much as 40%

"Packaged" Control Cabinet above includes Basis Weight Controller (top) and Stock Gate (or Valve) Position Recorder (below).



...with continuous, stepless automatic Foxboro Control of Basis Weight

Here's outstanding assurance of uniformity that's possible only when basis weight is put under continuous, automatic Foxboro control. Users report up to 40% reductions in basis weight variations!

Only this system takes its continuous machine-direction measurement across a *wide* averaging strip (14"). The special measuring circuit is self-compensating for deterioration of the radioactive material, and for changes in atmospheric pressure and temperature. Moreover, the operator merely turns a knob to preset the desired weight value.

Send today for new literature: Bulletin PD-108 describes this unique Basis Weight Control System; Bulletin PD-105-2 describes the measurement of entirely independent *across-the-sheet* weight variations with the Sheet Weight Profiler.

THE FOXBORO COMPANY, 788 NEPONSET AVENUE, FOXBORO, MASSACHUSETTS, U. S. A.

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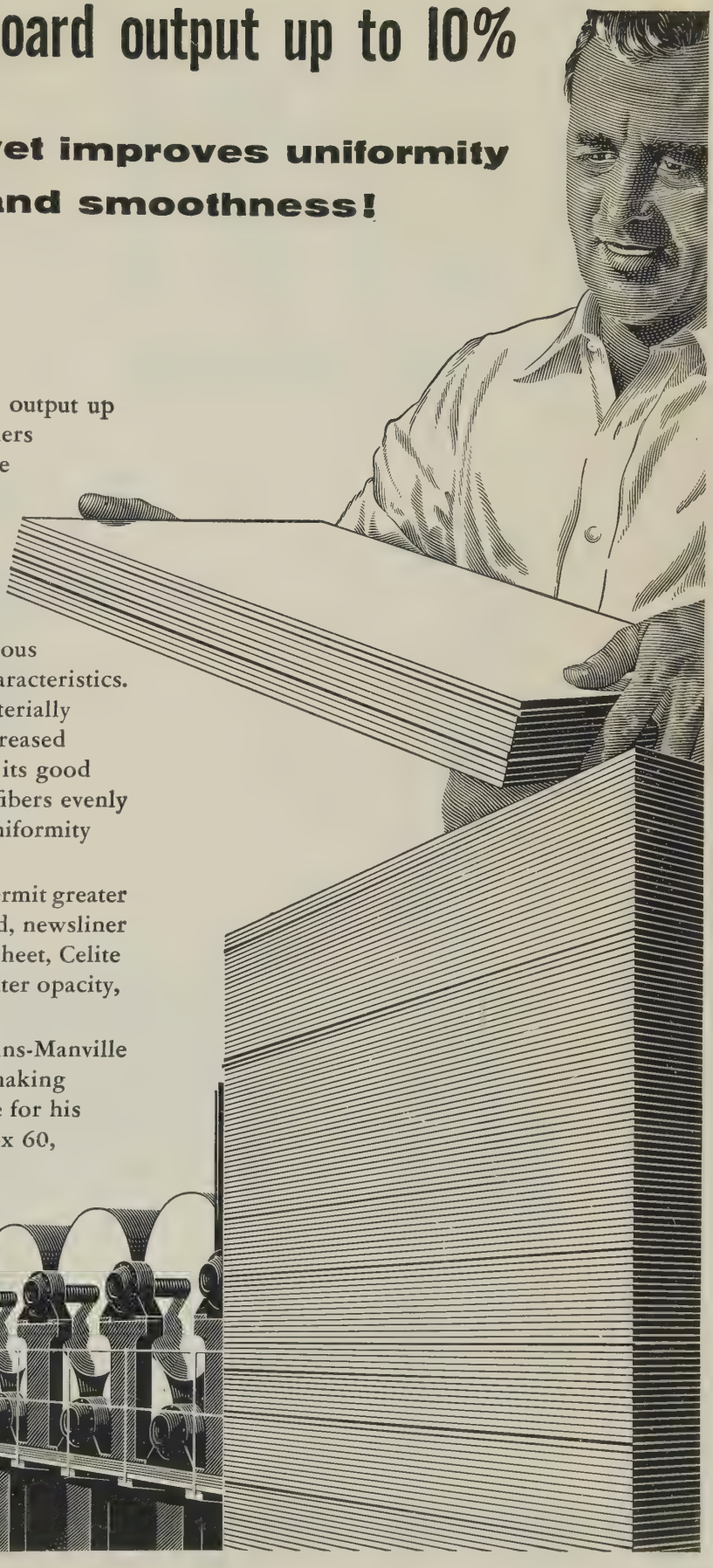
Beta-Ray Basis Weight Control

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

How Celite speeds board output up to 10%

...yet improves uniformity and smoothness!



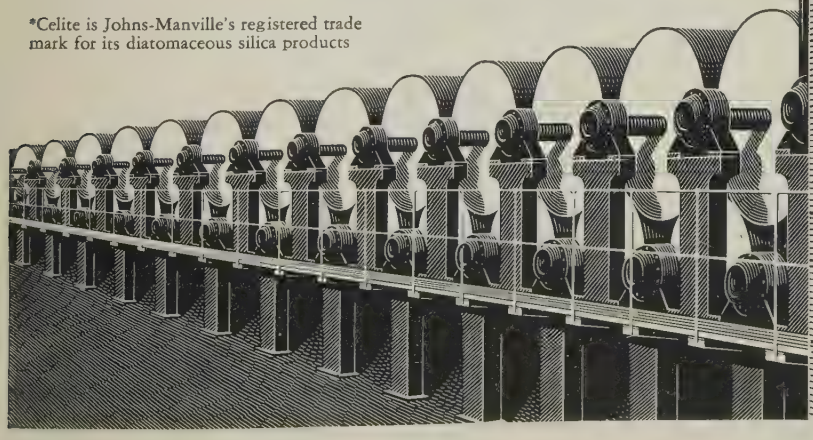
LEADING BOARD MILLS have increased output up to 10% by adding Celite* diatomite powders to their furnish. At the same time they have obtained better quality board with improved uniformity and smoothness. A test run in your mill will quickly demonstrate how you can secure similar results.

You will find that Celite is a highly porous material, with exceptional free-draining characteristics. Since it does not cake up or shrink, it materially improves drainage and drying, makes increased machine speeds possible. And because of its good suspension properties, Celite helps keep fibers evenly dispersed in water, resulting in greater uniformity of finished board.

These unique properties of Celite also permit greater bulk in machine boards such as chipboard, newsliner and solid manila. And for many types of sheet, Celite adds other desirable qualities such as greater opacity, higher brightness at lower cost.

To prove these advantages of Celite, a Johns-Manville Celite Engineer will gladly assist you in making trial runs in your mill. There is no charge for his services. Simply write Johns-Manville, Box 60, New York 16, N. Y.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products



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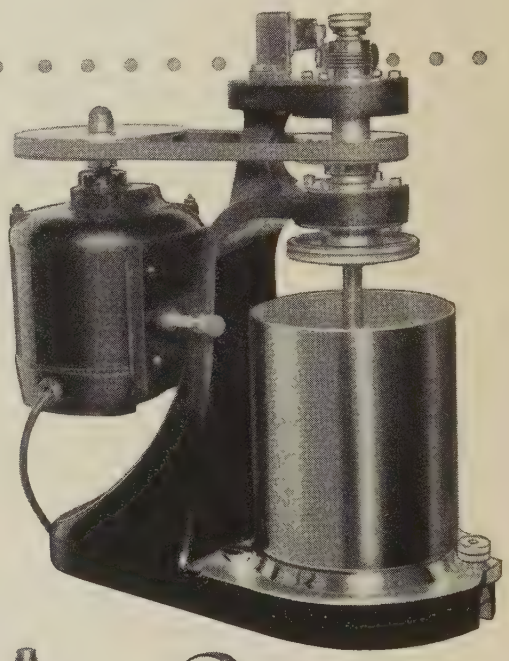
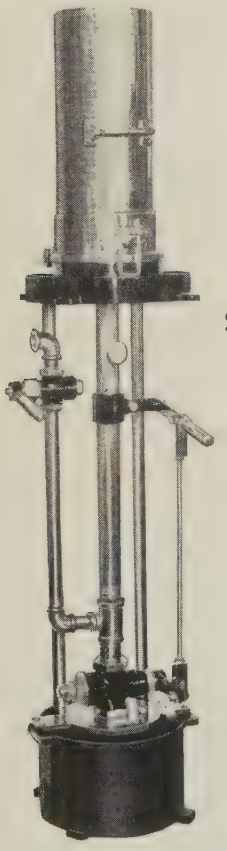
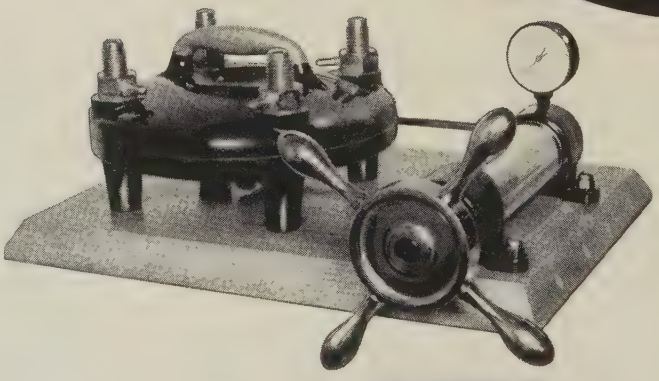
Pulp Testing and Sheet Making Apparatus



TAPPI
Disintegrator



TAPPI
Sheet Making
Machine



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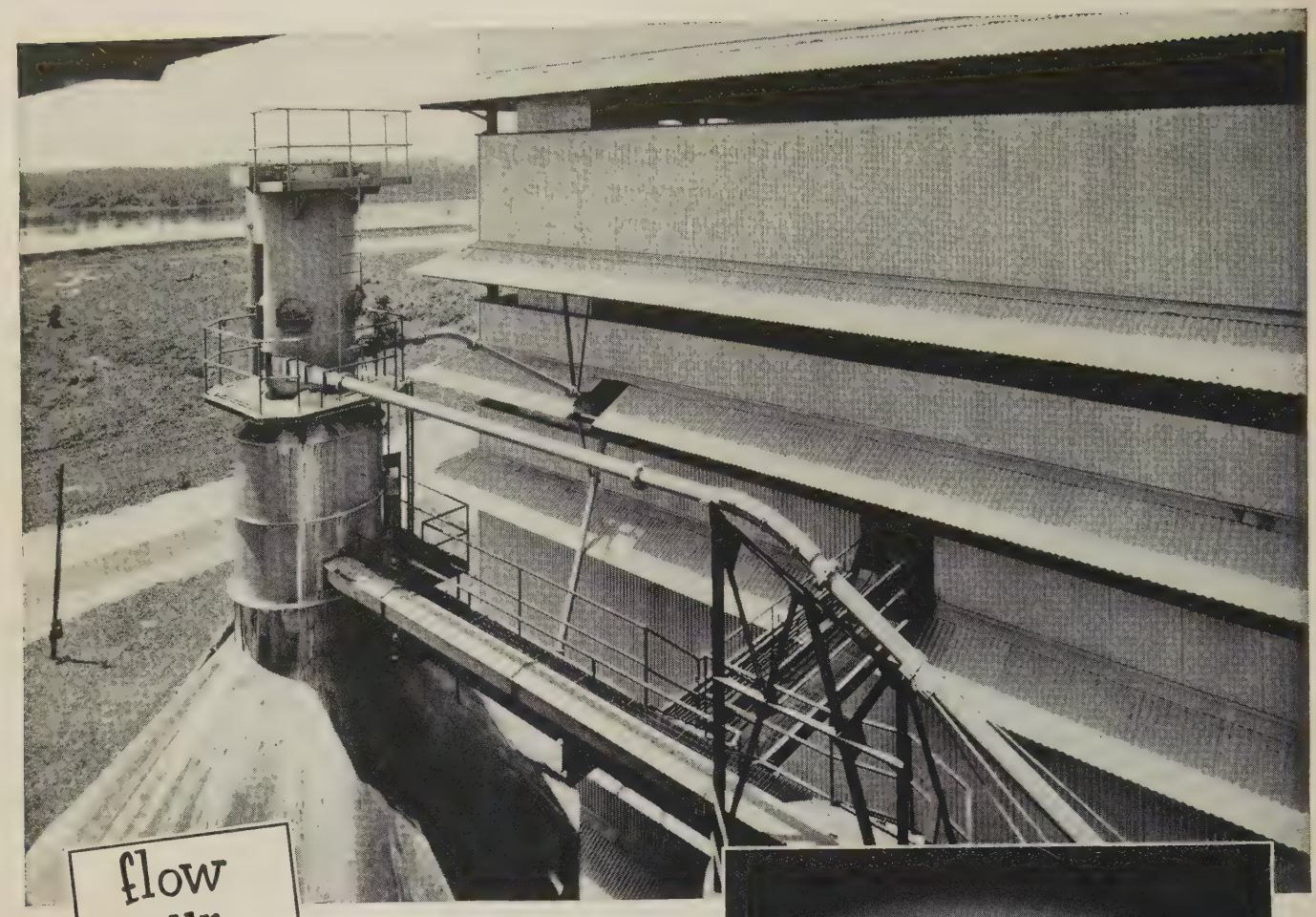
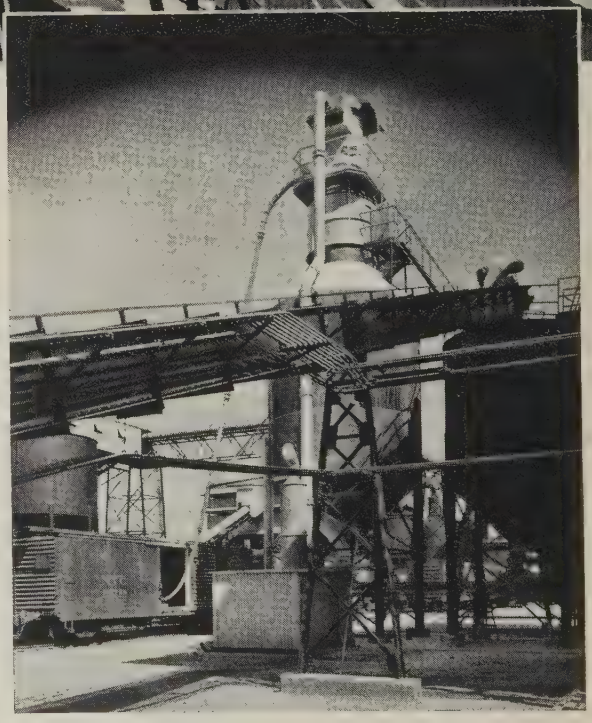


flow your bulk chemicals

from cars to storage...in-plant to process *with* The AIRVEYOR®



Handling your mill-supply chemicals . . . lime, soda ash, salt cake, starch and clays with the Airveyor—unloading from cars to storage or in-plant conveying—is the simplest, cleanest, and most economical method of doing the job.

Illustrated is an Airveyor installation in the south. Upper photo shows a system for unloading salt cake from cars to two storage bins at rate of 10 tons an hour. Also reclaims from storage and delivers to a service bin in the recovery building. Lower photo shows another system in the same plant unloading pebble lime at rate of 10 tons an hour, delivering to storage in the causticizing plant.

Well over 100 Airveyor systems are in service in the pulp and paper industry in the United States and Canada. This popularity is due to its inherent ability to perform, day in and day out, efficiently and with minimum attention and maintenance expense.

Fuller Company experience of over a quarter century in air-conveying places it in a top position to recommend and design a system that will give you the most economical results. A study of your operation will cost you nothing . . . may well show the way to consistently profitable operation and a smoother flow in production.

FULLER COMPANY, Catasauqua, Pa.
GENERAL AMERICAN TRANSPORTATION CORPORATION SUBSIDIARY
Chicago • San Francisco • Los Angeles • Seattle • Birmingham

FULLER COMPANY GENERAL AMERICAN TRADE MARK

Fuller
. . . . pioneers in harnessing AIR

A-207
1567

Put the NEW LOOK in Your White Papers

with New CALCOFLUOR* White PMS Conc.

Put more brightness and whiteness in your regular grades.

Impart intense brightness to your specialty grades where first impressions always count most . . . with CALCOFLUOR White PMS Conc.

This new CALCOFLUOR White is easy to handle, economical to use in the beater, size press, at the calender stack or in the coating color. Bleached whites and selected pastel tints are made brighter with CALCOFLUOR White PMS Conc.

More and more papermakers rely on CALCOFLUOR White PMS Conc. to meet the increasing demand for brighter whites. Consult your Cyanamid Dyestuff representative for further information on this new whitening agent for paper.

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BOUND BROOK, NEW JERSEY
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PROVIDENCE • LOS ANGELES • PORTLAND, OREGON

NORTH AMERICAN CYANAMID LIMITED
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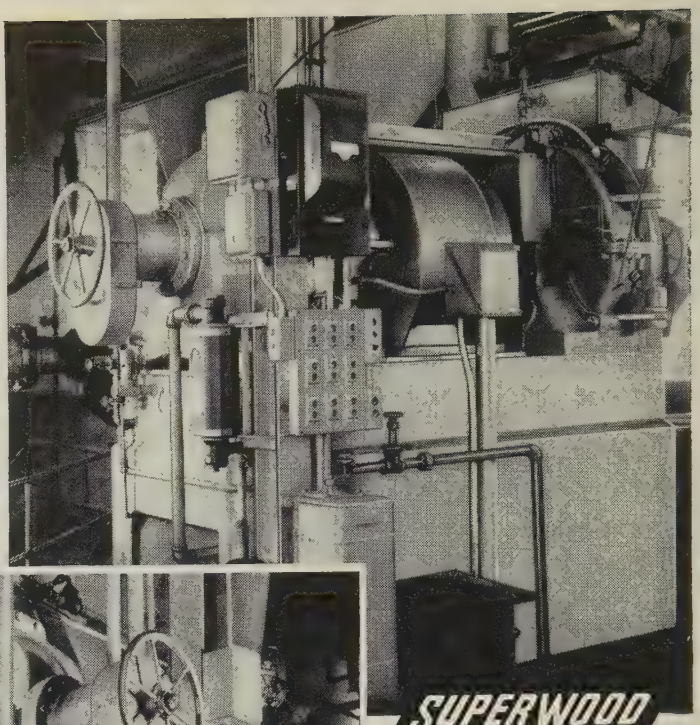
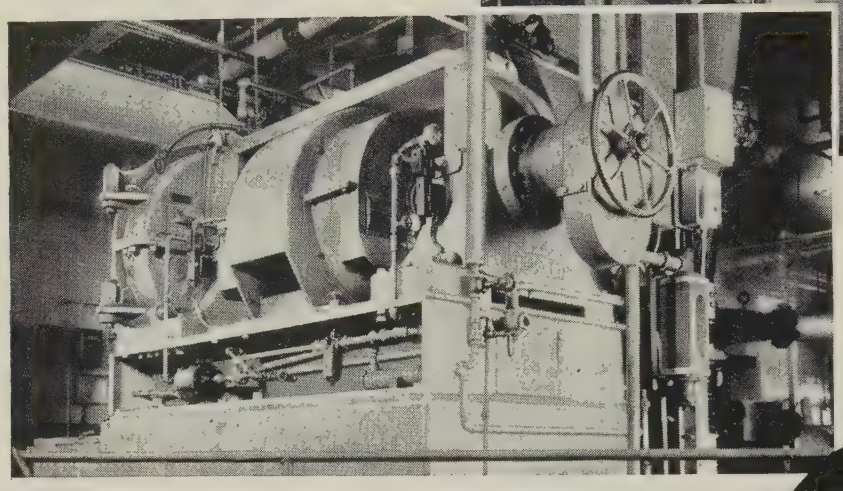
for economical **hardboard fiber preparation**

Superwood CORPORATION

chooses a

SPROUT-WALDRON 36-2 REFINER





SUPERWOOD HARD BOARD

The Sprout-Waldron 400 h.p. 36-2 Refiner at Superwood Corporation, Duluth, Minn. refines aspen Asplund fiber for SUPERWOOD hardboard. The refiner base cover has been removed to show the circulating oiling system. Above the refiner is the Uniflow Feeder built to Sprout-Waldron design and specifications. This feeder transforms a pulsating feed from the Asplund cyclone into a uniform refiner feed.

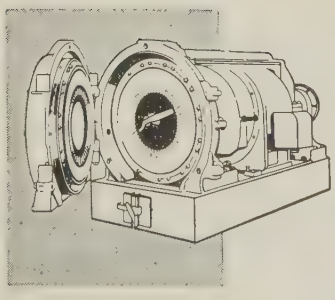
The SPROUT-WALDRON refiner is a leading producer of hardboard fiber

Single rotating disc design with peripheral control ring plus rugged construction for . . .

- **Uniform Fiber**
- **High Capacity**
- **Flexibility of Operation**
- **Low Maintenance**

For more information on hardboard fiber preparation, or any other pulping application, send for our file of technical and practical data. Write to Sprout, Waldron & Co., Inc., 38 Logan St., Muncy, Pa.

S W



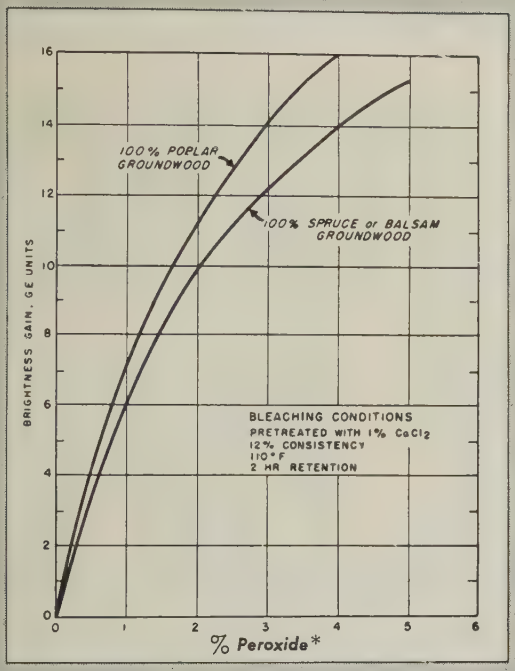
for your pulping problem—

SPROUT-WALDRON

PULP REFINERS

NOW... Increase groundwood brightness 10-14 G.E. units

with the Du Pont Peroxide Bleaching Process



BRIGHTNESS GAIN WITH VARYING PEROXIDE CONCENTRATION AT OPTIMUM TOTAL ALKALINITY

*As "Solozone," "Albone" or Combination of Both.

No other process gives you such high, stable brightness levels!

Now you can bleach groundwood for use in high-brightness papers with the Du Pont Peroxide Process. Higher concentrations of peroxides make high, heat-stable brightness levels possible—*increases of 10-14 G.E. units where needed!* And adjustments in bleaching formulas to improve brightness involve no changes in existing equipment.

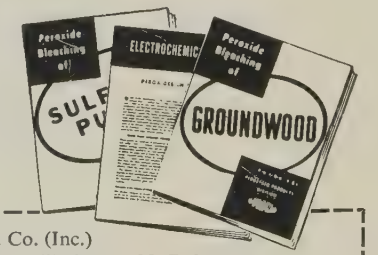
While increasing pulp brightness, this economical Du Pont process preserves the desirable characteristics of groundwood: high opacity, good formation and excellent printing properties.

You'll save with exceptionally high fiber yields. And peroxide bleaching minimizes brightness reversion on the paper machine.

Send for our new bulletin P62-1054 on High-Brightness Bleaching of Groundwood. It tells you how you can increase your groundwood brightness for more profitable papers. Mail coupon for your copy.

Send for these Du Pont booklets on peroxide bleaching of groundwood and sulfate pulps. They contain detailed information on formulations, procedures and equipment for the process, along with chemical control tests for bleaching solutions. Mail coupon for your copies.

Du Pont Peroxides are available for prompt delivery from conveniently located manufacturing plants. You can be assured of a dependable supply of top-quality peroxides for all your bleaching needs.



DU PONT
PEROXIDES

Albone®.....Hydrogen Peroxide
Solozone®.....Sodium Peroxide

DU PONT
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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept. T-8, Wilmington 98, Delaware

Please send me literature checked below:

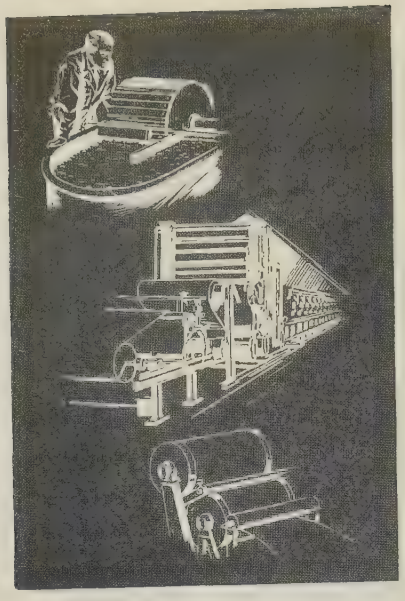
- ☐ Bulletin P62-1054, "High-Brightness Bleaching of Groundwood"
- ☐ Booklet, "Peroxide Bleaching of Groundwood"
- ☐ Booklet, "Peroxide Bleaching of Sulfate Pulp"

Name _____

Firm _____ *Position* _____

Address _____

City _____ *State* _____



HERCULES® STARCH meets all specifications for...

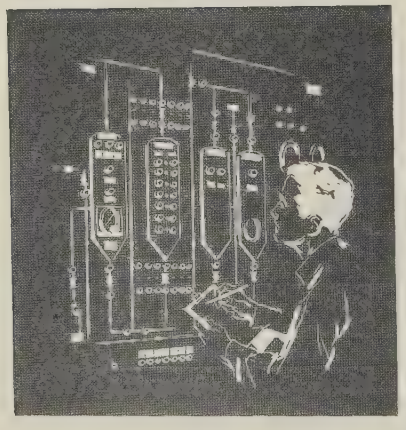
Beater Additive! Hercules Starch is especially effective in improving the retention and effectiveness of the rosin size.

Surface Sizing! Hercules Starch is a natural for this use. It imparts an improved printing surface with a better "pick test", and higher Mullen Factor.

Paper Coating! Hercules Starches make clear, more permanent films, and have greater uniformity from batch to batch. *We modify these starches to suit any coating equipment.*

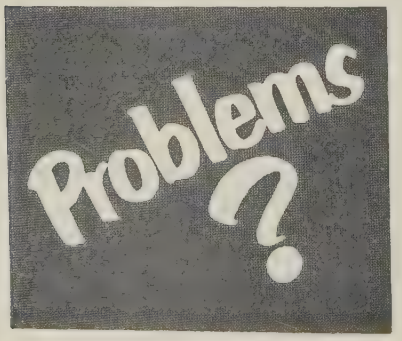
Calender Sizing! Hercules Starch is highly recommended for surface improvement. It is miscible with wax size and yields a paper board suitable for printing with gloss ink.

HERCULES STARCH FOR QUALITY PAPER



Controlled manufacture...

Hercules is manufactured by a newly perfected mechanical process. This new technique reduces human error and provides absolute control of product quality. Hercules is the ONLY starch produced by this method. Hercules is especially refined to help speed production, reduce "Down Time". It imparts a desirable snap and rattle to paper. In board manufacture Hercules starches give you a higher quality board.



Quick delivery...

The particular Hercules Starch you want is yours when you want it, in amounts required by your production schedules.

Service to the industry...

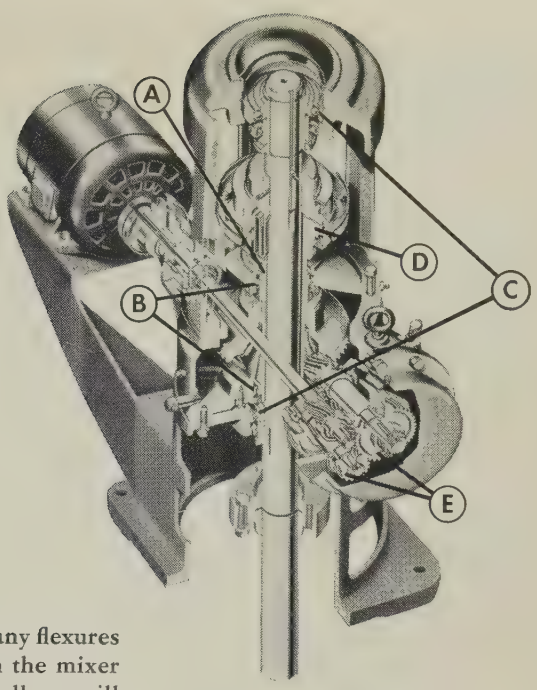
Take advantage of our free technological service. Our field and laboratory experts welcome an opportunity to help you solve your problems. Please write today.

Corn Products Refining Company
17 Battery Place, New York 4, N. Y.

Why you'll probably get

20 years' service

out of this fluid mixer



No, we can't guarantee that LIGHTNIN Mixers will mix fluids, day in, day out, for 20 years or more. But a great many of them do.

Here are just a few of the reasons why *you* may find that LIGHTNINs in your tanks enable you to hold depreciation costs down where they belong —and keep productivity *up* by minimizing shutdowns for maintenance and repair.

An important part of this LIGHTNIN Mixer is the gearing. And that's the part that needs most protection.

The gears you see here are mechanically insulated from any flexures or sudden shock loads on the mixer shaft. The gears drive a hollow quill (A), suspended in heavy-duty bearings (B) which carry power transmission loads only.

The mixer shaft is suspended in its own separate pair of adapter-type prelubricated bearings (C). The shaft passes through the quill with full clearance. Shaft and quill are connected at only one point (D) by a flexible coupling.

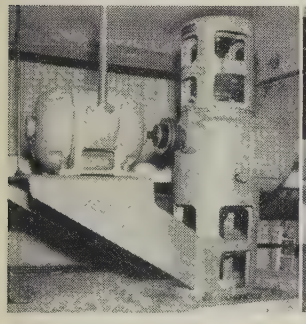
This hollow-quill construction isolates the shaft from the gearing. It saves wear on the gears, and protects them against damage. And it lets you remove the mixer shaft upward or downward, and you can even use shafts of different diameters.

Interchangeable speeds

The change gears (E) permit quick change of speed for a range of 16 standard AGMA speeds. You can change mixing speed, should it ever become necessary, by replacing two change gears with a pair of a different ratio. No special tools are required, and the mixer need not be removed from the tank.

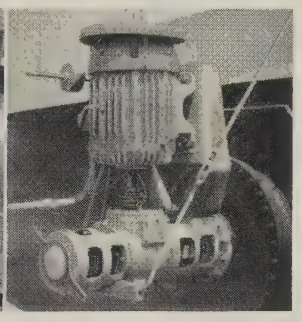
You can select from hundreds of power-speed combinations, in standard units, without need for special construction. Speeds other than standard can be had without limit.

Get set *now* to take advantage of the long-term savings you make with LIGHTNIN Mixers. For the full story, just call your LIGHTNIN representative, listed in Thomas' Register. Or write us today.



TOP ENTERING LIGHTNINs provide exact power-speed combination to fit the job. Models for open or closed tanks. Sizes 1 to 500 HP.

LIGHTNIN PORTABLE Mixers make any open tank an efficient mixing vessel. Thousands are in use. Electric and air driven types. Thirty models, ⅛ to 3 HP.



SIDE ENTERING units mix or blend fluids in tanks as large as 5 million gallons. Choice of stuffing boxes or rotary mechanical seals. 1 to 25 HP.

Lightnin® **Mixers**

MIXCO fluid mixing specialists

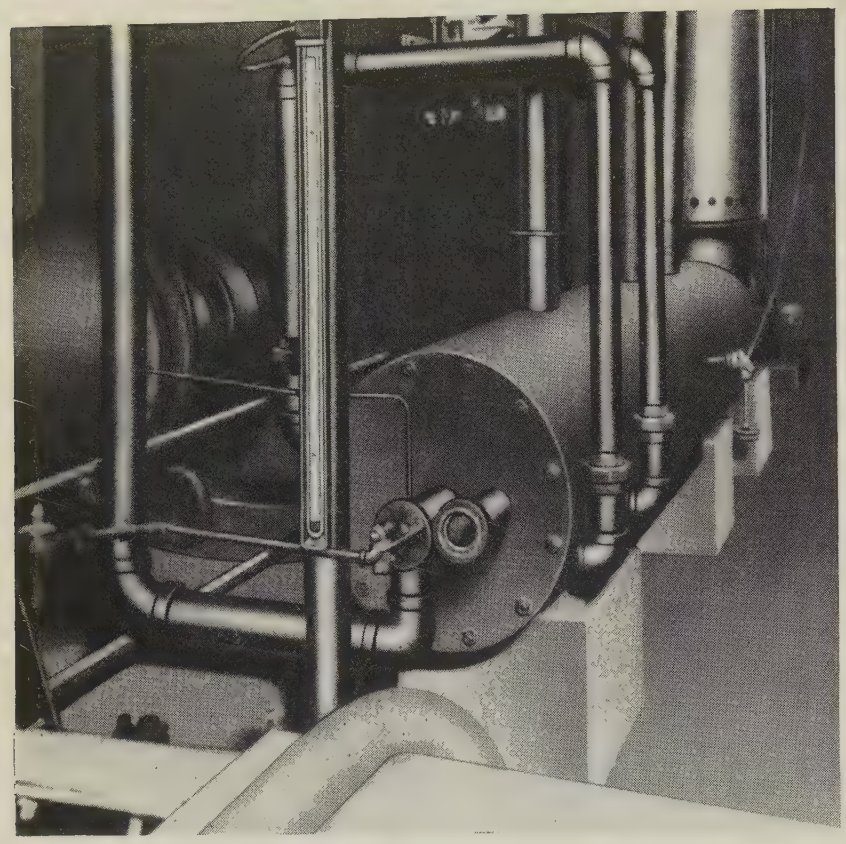
Get these helpful facts on mixing: cost-cutting ideas on mixer selection; best type of vessel; installation and operating hints; full description of LIGHTNIN Mixers. Free—no obligation. Just check data you want, tear out and mail to us today with your name and company address.

- ☐ B-102 Top Entering Mixers (turbine, paddle and propeller types)
- ☐ B-103 Top Entering Mixers (propeller types)
- ☐ B-104 Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air driven)
- ☐ B-109 Condensed Catalog (complete line)
- ☐ B-111 LIGHTNIN Rotary Mechanical Seals
- ☐ B-112 Laboratory Mixers

MIXING EQUIPMENT Co., Inc., 142-h Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

An Important New Development in Sulphur Burning . . .



Commercial installation of Chemipulp-KC 2½-ton sulphur burner. Note the compact design as compared with conventional burner shown in the background.

Chemipulp-KC *Jet Type* Sulphur Burner

More Compact—
More Efficient

Handles Any Type of Sulphur

Long Life—
Low Maintenance Costs

Fast Start-Up
Instant Shut-Down

In the new Chemipulp-KC Burner the molten sulphur is sprayed into the burner as a fine mist. The secondary heated air is then introduced in several stages, resulting in clean operation and long service life.

Because of the small mass, the burner quickly reaches its maximum efficiency temperature of 2100° F., minimizing the production of SO_3. This burner operates efficiently at all SO_2 gas concentrations between 12% and 18½%. At its operating temperature of 2100° F. the bitumen in the dark sulphur is completely burned, so that dark sulphur as well as bright sulphur is efficiently burned. Shut-down is instantaneous.

This unusually compact unit is now available in capacities of 1, 2½, 5, 12, 15 and 25 tons per day, and each different size burner operates efficiently at loads of 25% to 150% of rated capacity. Both installation and maintenance costs of this new burner, which is a development of the KIMBERLY-CLARK CORPORATION Research Program, are considerably lower than rotary burners and combustion chambers of equal capacity.

Chemipulp Process Inc.

Woolworth Bldg. Watertown, N. Y.

Associated with Chemipulp Process Ltd., 403 Crescent Bldg., Montreal

Pacific Coast Representative, A. H. Lundberg, 308 Orpheum Bldg., Seattle 1, Wash.

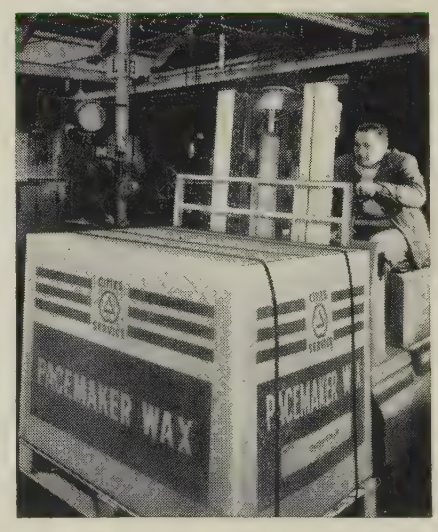
Marcal saves time, money, space with Cities Service CarTONS!

One ton units of Pacemaker Wax prove invaluable to efficient, economical operation at Marcalus Manufacturing Co., Inc., East Paterson, N. J.

The Marcalus Manufacturing Co., Inc.—better known by its trade name, Marcal—is constantly alert for new ways of reducing production costs and increasing product quality. One such method is the use of Cities Service Pacemaker Wax in unique, easily handled one ton units. Unlike other units, these carTONS, as they're called, allow simplified vertical stacking, thus enabling considerable savings in storage space. In addition, because they're one ton packages, rather than the old 100 pound type, they eliminate considerable handling time and waste disposal problems. Where Marcal formerly had 20 cartons to handle and later dispose of, there is now only one.

Marcal says further that as for the quality of the wax itself, Cities Service Pacemaker Wax ranks with the very best. Its excellent properties include high gloss and gloss retention, maximum moisture-vapor resistance, and unsurpassed blocking resistance. In view of these characteristics, coupled with excellent service, Marcal recommends Cities Service Pacemaker Wax to any user.

Your Cities Service Representative can tell you of many others who are equally satisfied, or you can write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

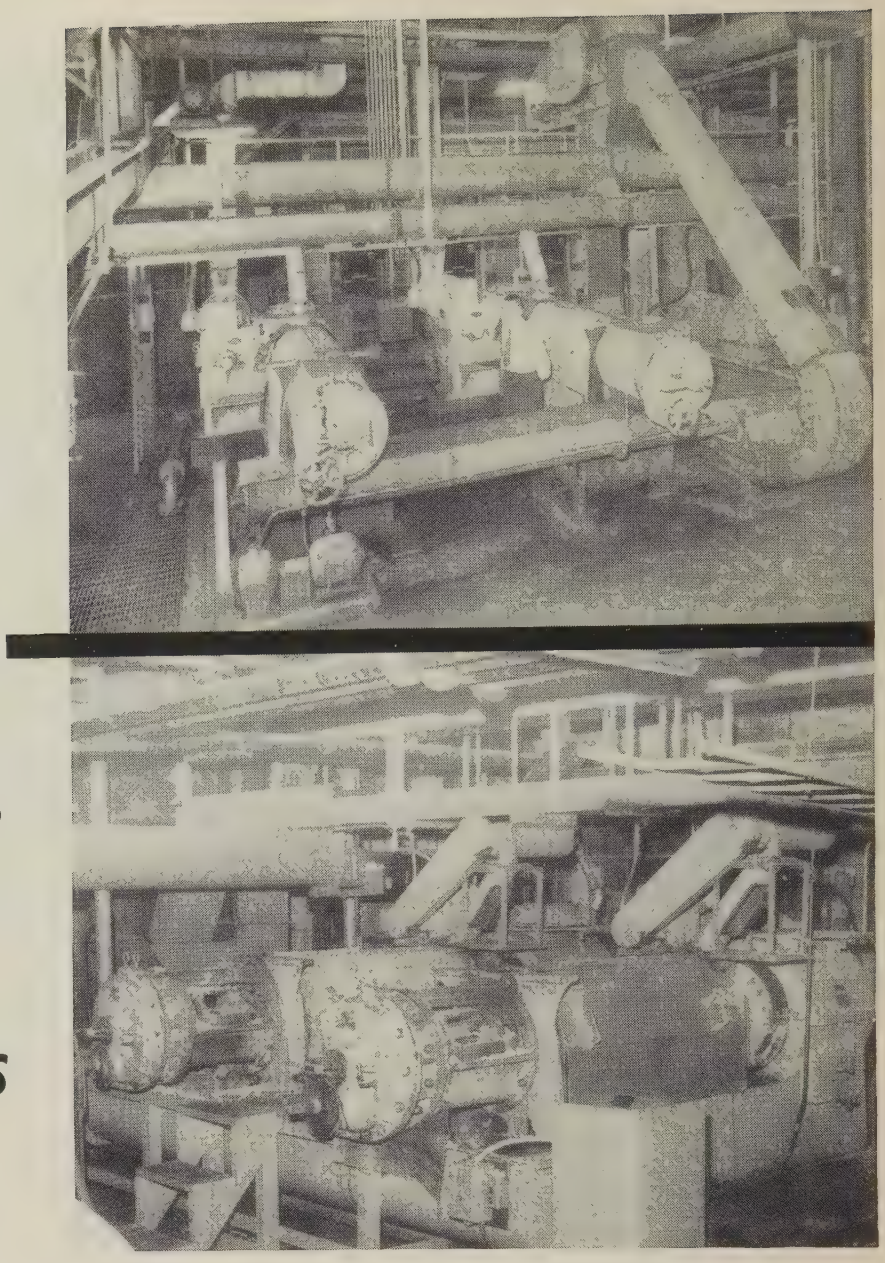


One ton carTONS of Cities Service Pacemaker Wax mean less cartons to store, less cartons to handle, less cartons to dispose of, and less man hours spent in these operations, as proved at Marcal Paper Products. In addition, Marcal feels Pacemaker is best for high gloss and gloss retention, and unsurpassed blocking resistance.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

THE FIRST 2 INSTALLATIONS OF Bauer PRESSAFINERS



Although the Pressafiner is a new and unique machine, three installations are already operating and three other installations are being made.

Pressafiners afford the following advantages in NSSC pulp mills:

1. Stream pollution is controlled by a 65% reduction of total mill B.O.D. requirements.
2. Pressafiners remove 50% of the total B.O.D. rich waste liquors associated with NSSC chips.
3. The expressed liquor combined with the digester blow-down liquor is disposed of as highly satisfactory road binder.
4. A reduction of 20% to 25% in total refining power may be effected by the pre-refining action of the Pressafiner.
5. Stiffness of the corrugating medium is retained with 20% to 30% increase in headbox freeness.
6. Removal of waste liquor has prolonged felt and wire life.
7. Operation of Pressafiners is simple.

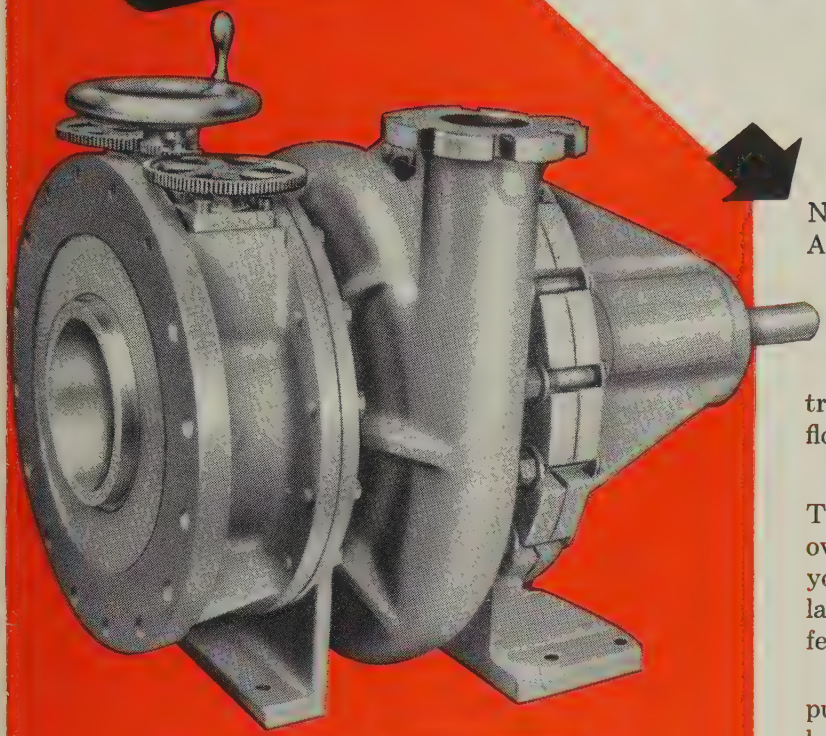
These data are presented in the conclusions stated in a paper, "Development and Use of the Pressafiner at Green Bay," by William Nelson, Technical Director of Green Bay Paper & Pulp Co., Green Bay, Wisc. If you haven't read it, we'll gladly send you a reprint.

THE BAUER BROS. CO.

1757 SHERIDAN AVE. • SPRINGFIELD, OHIO

ALLIS-CHALMERS
Proportioning
PUMP

Gives Positive Stock Delivery Control



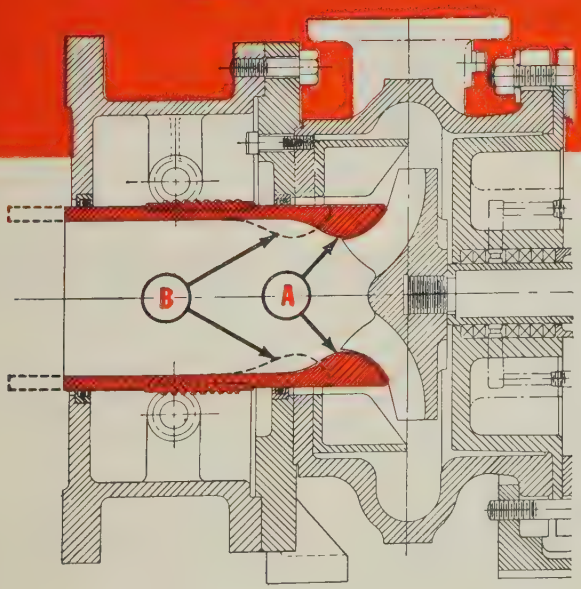
No need to regulate pump speed using Allis-Chalmers new proportioning pump.

Key to this revolutionary *ACAP* pump is an internal bypass mechanism — bolted on the inlet of a single-suction pump. Bypass mechanism can be controlled automatically or manually to reduce flow of stock when needed.

Provides Agitated Stock Flow

This pump gives positive, accurate control over paper stock delivery. It also permits you to maintain constant agitated recirculation for blending purposes without affecting uniform delivery of stock.

Get complete details on the new *ACAP* pumps for proportioning, fan service or head box supply. Contact your nearby district office or write Allis-Chalmers, Milwaukee 1, Wisconsin.



ACAP is an Allis-Chalmers trademark.

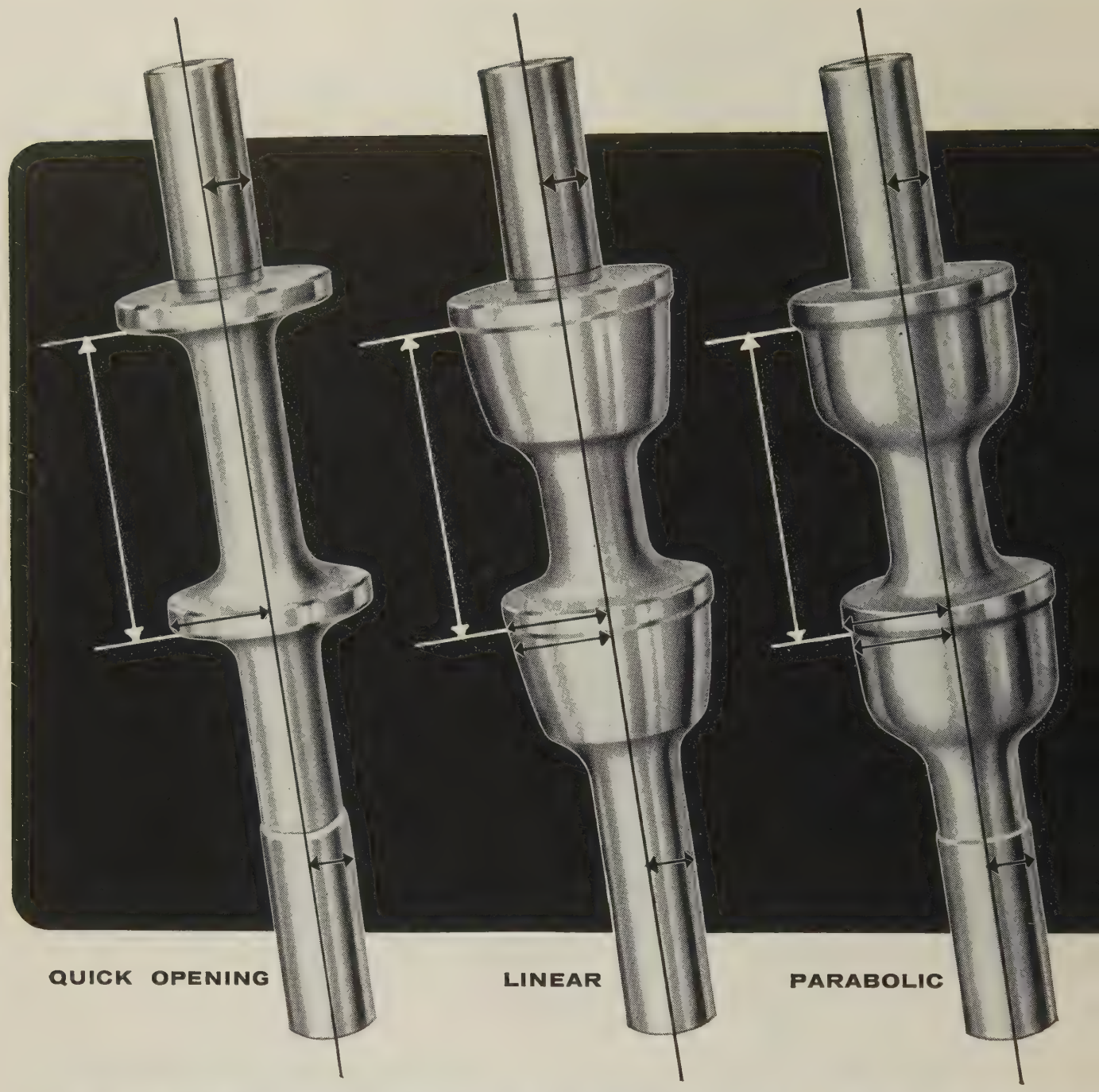
- ***Operates at any point on the curve***
- ***No Valves to clog or clean***

Adjustment of the actuating mechanism slides the bypass cylinder toward or away from the impeller. The clearance between pump end of the cylinder and the impeller determines the amount of stock recirculation — regulates the flow at the discharge nozzle.

At Position *A* (see diagram) outlet flow is at maximum, recirculation slight; at Position *B*, outlet flow is minimum, recirculation is maximum.

A-4773

ALLIS-CHALMERS

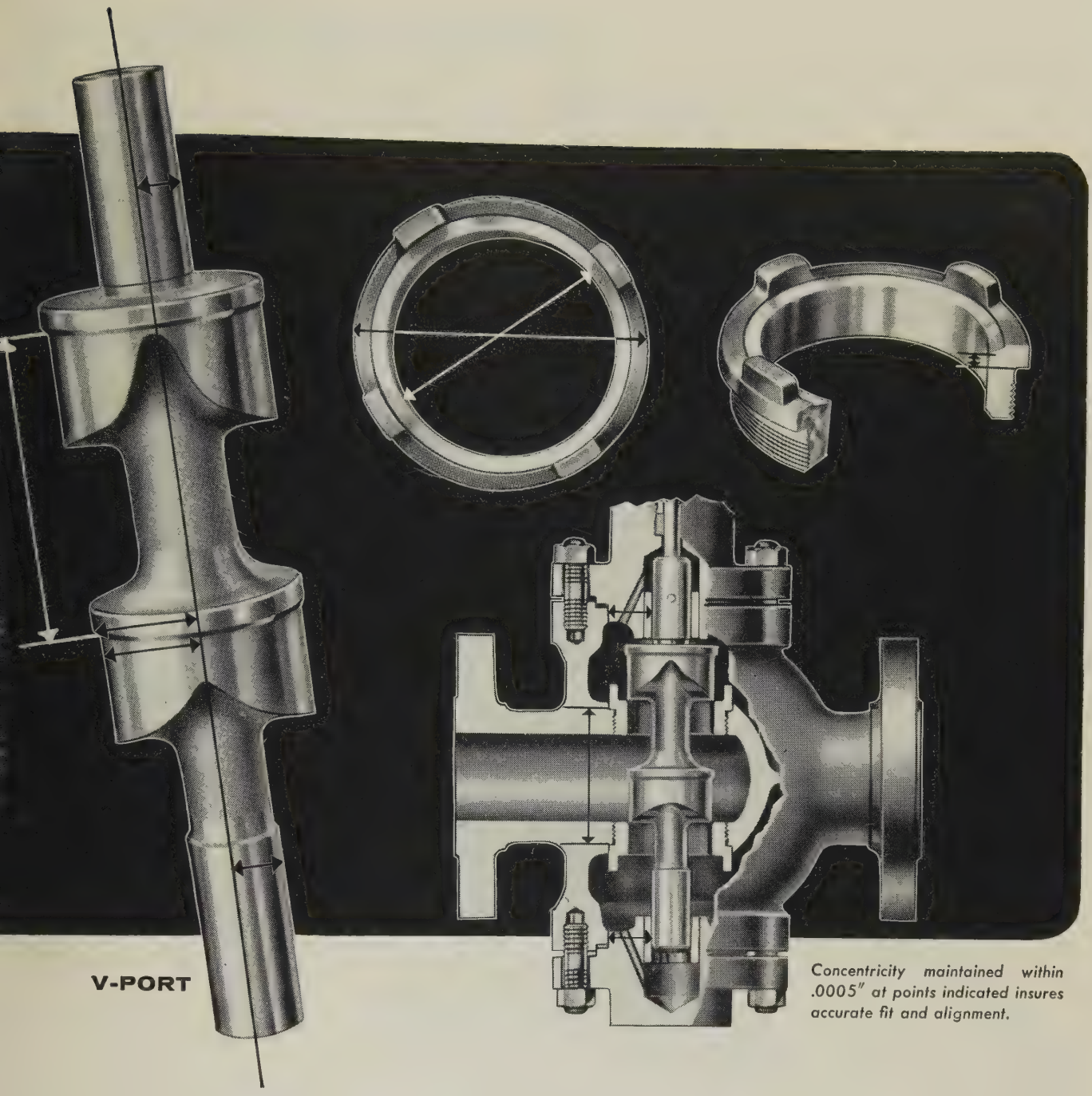


INTERCHANGEABLE PARTS

An Important Factor in Uniform Quality of Masoneilan Control Valves

You have a right to expect to be able to install replacement parts without recourse to a machine shop for custom fitting. When you use Masoneilan Control Valves you *get* parts that fit. For Mason-Neilan precision methods, automatic machines and specially designed tools and gages, plus rigorous inspection, eliminate the maintenance man's headaches and reduce costly time out of service.

By maintaining this precise uniformity, Mason-Neilan makes certain that every valve will be in perfect alignment and that any



V-PORT

Concentricity maintained within .0005" at points indicated insures accurate fit and alignment.

parts you may install later will also be in perfect alignment.

Moreover, because valve plugs of comparable size but different flow characteristics are interchangeable, conversion is a comparatively simple operation.

These quality features, added to other outstanding qualities of Masoneilan Control Valves, offer you low *cost* at comparable *price* — and over-all cost not price is the valid comparison.

Investigate the practical advantages of Masoneilan Control Valves.

Write for complete data.

MASONEILAN

MASON-NEILAN REGULATOR CO.

1207 ADAMS STREET, BOSTON 24, MASS., U. S. A.

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco Boise • Louisville • Salt Lake City • El Paso • Albuquerque • Odessa • Charlotte • Los Angeles Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Dallas • Seattle Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

You get more than wet-strength

with RCI

BECKAMINE

P-841-30

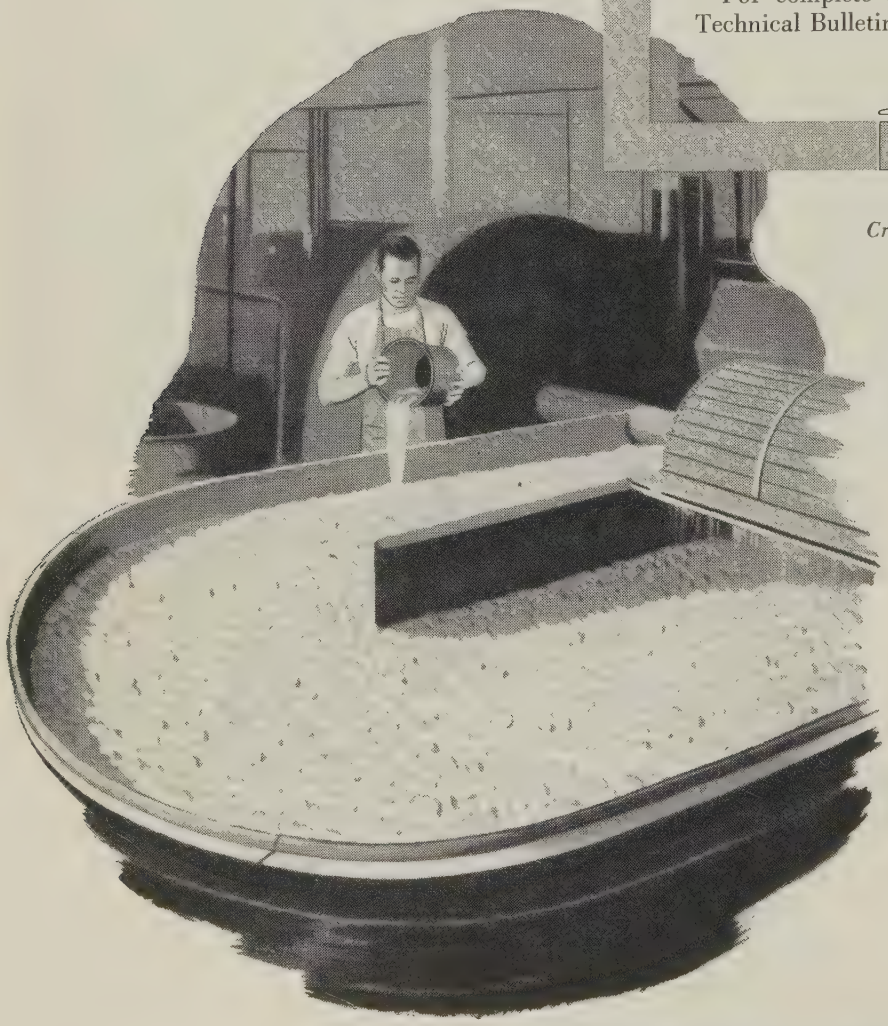
• You realize a number of *other* important advantages besides *greater wet strength* with this cationic-type urea-formaldehyde Reichhold resin.

You also *increase dry strength and wax pick* when you add it with starch to bleached and unbleached kraft or sulfite, ground wood, rag or mixes of these pulps.

This BECKAMINE enables you to *save 50-70% in rosin size.* When you use 0.5% of P-841-30 solids after the refining operation, your rosin size goes further. The strong cationic charge on P-841-30 results in superior distribution and retention of the size.

Last but not least, this versatile RCI resin helps you achieve *better tub and calender sizing* in conjunction with starch. P-841-30 aids in laying fuzz, improves scuff resistance and dimensional stability, waterproofs starch.

For complete details, write to Reichhold for Technical Bulletin P-3.



RCI

Creative Chemistry . . .
Your Partner
in Progress

REICHHOLD

Synthetic Resins • Chemical Colors • Plasticizers • Phenol
Formaldehyde • Glycerine • Phthalic Anhydride • Maleic Anhydride
Sodium Sulfate • Sodium Sulfite • Pentaerythritol • Pentachlorophenol

REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.

The Rheology of Cooked Wood

I. Introduction and Discussion

J. E. STONE

A discussion is given of the objectives of pulping research in terms of cell wall structure. Particularly concerned with high yield pulping, the discussion follows the interrelationships between degree of cooking, fiberizing energy, and rupture of the various layers of the cell wall.

A SERIES of investigations has been started in these laboratories to try and look a little deeper into the mechanism of high-yield pulping, particularly the fiberizing aspects of it, and the function of this paper is to present a general discussion of the subject and what is being attempted.

One of the major objectives in pulping is the separation of individual fibers from the original gross wood structure. Various methods are adopted to accomplish this, depending on the product required, but they all involve a combination of chemical or physicochemical softening of the wood and mechanical attrition. The two are in some inverse relationship to one another—the greater the amount of softening, the less mechanical force is required to fiberize the wood; and the smaller the amount of chemical action, the greater must be the expenditure of energy to produce a pulp. At one end of the scale there is groundwood with only water at moderate temperatures to give a softening action so that considerable amounts of fiberizing energy are consumed. At the other end there are the full chemical cooks which permit chips to be broken apart easily. Depending on the ratio of mechanical to chemical action, the individual fibers will be more or less damaged. The objective of this series of investigations is to determine the relationship between these three factors: (1) the chemical or physicochemical treatment given a piece of wood; (2) the kind and amount of mechanical action needed to fiberize this treated wood; and (3) the extent of cell wall damage. It will be particularly concerned with high-yield pulping.

The work is based on four premises:

1. The primary function of pulping is to separate one fiber from another through a plane of cleavage which lies in the middle lamella.
2. The secondary function of pulping is the dissolution of various wood components.
3. Cell wall damage is a function of the force required to separate two fibers.
4. The cell wall should remain as intact as possible for as long as possible.

These premises will be examined in the above order, and to help in the discussion, a diagram of a cross section of a woody cell is given in Fig. 1. The cell wall proper consists of a thin primary wall (cross-hatched) which is heavily lignified and contains a small percentage of cellulose micelles with a woven texture. The secondary wall is made up of three layers which differ in thickness, micelle orientation, and cellulose and lignin content. The inner and outer layers have a micellar orientation at a large angle to the fiber axis whereas the thick central layer has micelles at a small angle to the fiber axis. Joining two such cell walls together is the middle lamella (black in diagram) which cannot be considered a true part of either cell. It is highly lignified and has no optically visible fibrous structure. It is difficult to distinguish the middle lamella from the highly lignified primary walls on either side of it. With this picture in mind of the system involved in pulping, attention will now be directed to the premises listed above.

1. The primary function of pulping is to separate one fiber from another through a plane of cleavage which lies in the middle lamella. Garland (*1*) found by microscopic examination that untreated (airdry or green) shortleaf pine rarely, if ever, fails in the middle lamella when broken in tension or compression. Instead the cells either broke right across a double wall or separated between the central and outer layers of the secondary wall. Wardrop (*2*) concluded that *Pinus radiata* broken in tension also tended to fail between the central and outer layer of the secondary wall. Evidently in uncooked wood at room temperature the middle lamella is stronger than the cell wall proper. This general conclusion is supported by the evidence of other workers (*3–6*) and is fundamental to the whole concept of cooking as an aid to fiber separation. The practical result of this is that when an attempt is made to fiberize untreated wood a high proportion of shortened fibers, fiber fragments, and fiber bundles is obtained. It is only by paying particular attention to the way in which the wood is fiberized (grinding) that a pulp of any use at all can be obtained, and even then the strength properties are very low. In grinding, the fiberizing force is applied to the wood as a rolling tangential shear with the fiber axis parallel to the stone axis, and in this way fiber length is maintained to a greater extent than if wood chips were impact loaded at random as in say a disk fiberizer. Groundwood pulp may also be as good as it is because of a local momentary rise in temperature to a point where the wood softens, or because, as suggested by Campbell (*7*), the compression waves set up in the wood by the stone grits striking the wood 6000 times per sec. may have a selective action on the lignin.

The reasons for not wishing to break the double cell walls across, and so shorten the fibers, may be based upon the desire to maintain a high ratio of fiber length to diameter. The reasons for not wishing to separate two cells at the junction of the central and outer layer of the secondary wall of one of them are less obvious. They will be discussed further under Section 4, but to advance the discussion at this point, the reasons are: (1) if the wood is in a condition to permit cell separation

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between layers of the secondary wall it is probably in a condition to permit fiber shortening also; (2) separation within the secondary wall of one cell leaves the other cell with a complete wall, the middle lamella, and part of the broken cell's wall attached to it, and on further delignification, this fragment of cell wall will become

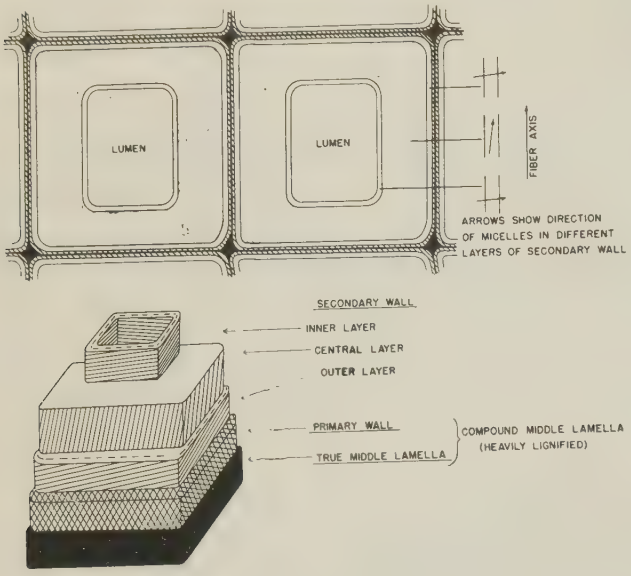

Fig. 1. Cross section of a woody cell

detached and form debris; (3) the cell whose wall has been damaged is susceptible to degradation.

If it be assumed therefore that for the production of most types of pulps it is desirable to choose conditions which permit the separation of all cells from one another with intact walls, then it is necessary to weaken the middle lamella relative to the cell wall proper. Weakening the whole double wall is not enough, because although the wood may break up into fragments more easily, it may still be failing in the secondary wall. In order to weaken the middle lamella relative to the secondary wall, use is made of their different composition and properties. Lignin differs chemically from cellulose, is nonfibrous, and is said to soften at high temperatures. Therefore, the middle lamella can be weakened by using a chemical which reacts with and dissolves lignin, or reacts with and introduces hydrophilic groups such as hydroxyl, sulphhydryl, and bisulphite, but without dissolving the lignin. Another method (used commercially in the Asplund process) is to heat the wood to a temperature at which the lignin softens (160°C.). The yield is high in this latter process because there is no dependence on dissolving action.

2. *The secondary function of pulping is the dissolution of various wood components.* For many pulps, it is necessary to remove some of the components from the original wood because their color or physical properties would give undesirable characteristics to the final sheet. In other cases the dissolving of wood components during cooking is merely a result of the inability to fiberize the wood in any other way. If the final sheet characteristics call for the removal of lignin and hemicellulose, and the removal of these two constituents is necessary for successful fiberizing, then there may appear to be little point in separating the two functions of pulping. However, several practical advantages would result from a separation of these functions. If wood could be separated into intact fibers with no cell wall damage and with no dissolution of material, then instead of the cooking liquor having to diffuse and penetrate to the center of a wood chip, and then diffuse through a cell wall to the lignin in the middle lamella, followed by the outward diffusion of the reaction products, the isolated fiber would have the middle lamella on the outside, fully exposed to the cooking liquor right from the start. Apart from the increase in reaction rate and the much more uniform cook that this would lead to, it might also lead to a favorable change in the relative rates of lignin and carbohydrate removal. It might also permit the use of delignifying agents which could not reasonably be used on a wood chip. The chemical used to help in the fiberizing (if a chemical is used) is not necessarily the best for delignifying so that by separating the functions of pulping it may be possible to choose optimum (and different) conditions for each. The secondary function of removing unwanted wood constituents is then the first stage of a process which is continued and completed by bleaching.

Several attempts have been made to fiberize wood first and delignify later. Jayme and Grögaard (*8, 9*), who were seeking to obtain isolated fibers in order to avoid diffusion problems, speed up the reaction and develop a continuous pulping process, disintegrated wood in an Asplund defibrator and cooked the resulting pulp by the sulphite and sulphate processes. The former gave a worthless pulp from which handsheets could not be made. Somewhat better results were obtained by the kraft process, and considerably better results by a chlorination followed by alkaline treatment (*10*). The explanation given for the degradation of Asplund fibers is that the lignin in whole wood protects the cellulose whereas the Asplund treatment destroys the continuity of the interpenetrating cellulose-lignin system and hence the protective action of the lignin. The picture evoked by this conclusion is not too clear. Although the attempt to obtain and delignify isolated fibers was not too successful under the conditions used by Jayme, *et al.*, it is possible that a modification of these conditions might prove fruitful. Possibly a lower temperature in the Asplund, or the presence of a neutral buffer during the heating and fiberizing, or a neutral sulphite cook of the isolated fibers rather than an acid or alkaline cook might have shown more promise. Nolan, *et al.* (*11*) claimed that by hammermilling steamed pine chips to form "matchsticks" they were able to obtain a kraft pulp in a shorter time than from whole chips, and the pulp was superior in tear and double fold, so it appears possible that by choosing the appropriate conditions a process may be developed for separating the two functions of pulping. It will be one of the objectives of our experimental program.

3. *Cell wall damage is a function of the force required to separate two fibers.* If this premise is true, then the measurement of fiberizing energy would be a useful tool in determining the optimum conditions for fiberizing. Should cooked chips be fiberized hot or cold for example? There are plenty of qualitative data to suggest that the premise is true, but very little of a quantitative nature and certainly not enough to answer a number of pertinent questions in this field. Qualitatively speak-

ing, it is obvious that uncooked wood chips are harder to break apart than well-cooked chips. Softened or cooked logs, as in the chemigroundwood process, consume less grinder power per ton of pulp than uncooked logs and the fibers are much more intact from the cooked wood. In the Asplund process there is a steady drop in power consumption as the temperature rises and at about 160 to 170°C. there is a sudden and considerable drop in power which corresponds to the temperature at which useful fibers are obtained (*12*).

A consideration of cell wall structure suggests that the use of fiberizing energy as a criterion of cell wall damage should be treated with caution in some circumstances. It is easily possible to conceive of conditions, for example, which would leave the middle lamella relatively strong and weaken the secondary wall instead. The energy required to reduce the wood to fragments would thus decrease, but be due to a weakening of the cell wall in the wrong place. Acidic conditions which attack carbohydrate but not lignin might result in a situation such as this.

Nevertheless it is felt that the force required to break a piece of wood can be a very valuable tool if used in conjunction with other tests for fiber damage and with an awareness of the properties of the various parts of the cell wall. Consequently a major part of our experimental program will consist of measurements of the force required to cause wood to fail, varying the pretreatment of the wood and the manner of applying the force. The next paper in this series, for example, will be a study of the force required to break birch in radial shear at temperatures varying from 25 to 180°C. and with the cell walls swollen (heated in sodium bicarbonate solution) and unswollen (heated oven-dry in oil). The plane of failure will be examined microscopically. Other work being planned includes studies of breaking force as a function of lignin content, hemicellulose content, swelling of cell wall (by pH changes), rate of loading, and several other factors.

4. *The cell wall should remain as intact as possible for as long as possible.* Hägglund states (*13*) "It is particularly important for the maintenance of strength that the wood shall not be disintegrated during the cooking since. . .isolated fibers are strongly attacked by cooking liquor." He found (*14*) that even the defibering occurring in a rotating digester led to poorer pulp than that from a stationary one. This was particularly true of sulphite cooks but alkaline conditions also degraded the fibers. Hägglund also asserts (*15*) that the damage caused during the chipping of wood which has been heated in water preparatory to drum barking and chipped while still hot results in a sulphite pulp with diminished strength. Green and Yorston (*16*) and Anderson (*17*) found that handmade chips led to much stronger pulps than machine-made ones. Weak pulp is obtained from hammered or crushed wood (*18*). The experience of Jayme and Grögaard (*8, 9*) using Asplund fiber has already been quoted.

It is difficult to understand how an isolated fiber could be degraded by any cooking liquor if the fiber consisted of the intact cell wall with its own half of the middle lamella coating it on the outside. As suggested previously, such a fiber should actually be easier to delignify and leave with a high carbohydrate content than a fiber cooked in the interior of a wood chip. Presumably it is only damaged fibers which become degraded during cooking and in Section 1 a number of obvious reasons for this degradation are given. An important reason that was not mentioned specifically follows from a consideration of the angle of micellar orientation in the various layers of the secondary wall (see Fig. 1). The central layer is a thick one and has its micelles orientated at a small angle to the fiber axis. Much of the strength of the fiber lies in this layer. Because of the micellar orientation of the central layer it can swell strongly in a direction normal to the fiber surface, but is restricted in this direction by the outer layer which has a micellar orientation almost at right angles to the fiber axis and therefore acts as a protective and restrictive girdle about the fiber.

The primary wall, highly lignified and reinforced with a basket weave of cellulose micelles, supports the outer layer of the secondary wall in its function of resisting transverse swelling.

It has been seen that uncooked wood tends to fail between the central and outer layers of the secondary wall when subjected to mechanical action, so it follows that such mechanical action is liable to disrupt or strip off the protective outer layers and permit a serious weakening of the whole wall. This explanation as to why mechanical action on wood (chipping, crushing, action of rotating digester, Asplund fiberizing, etc.) has an adverse effect on the quality of pulp subsequently produced from it, seems to be more reasonable than theories based on a hypothetical protective action due to lignin. If wood is to be fiberized before cooking it seems necessary therefore to choose conditions which not only retain fiber length but also leave each fiber with an intact three-layered secondary wall. Alternatively, a delignifying process should be chosen which is mild enough to be used with damaged secondary walls without causing them to deteriorate still further through swelling or hydrolytic attack.

LITERATURE CITED

1. Garland, H., *Ann. Missouri Botan. Garden* 26: 1–94 (1939).
2. Wardrop, A. B., *Australian J. Sci. Research* B4, No. 4: 391–414 (1951).
3. Robinson, W., *Phil. Trans.* B210: 49 (1921).
4. Koehler, A., *U. S. Dept. Agr. Tech. Bull.* No. 342 (1933).
5. Frey-Wyssling, A., *Schweiz. Verband Materialprüfung. Tech. Ber.* No. 36: 29 (1938).
6. Greenhill, W. L., *J. Council Sci. Ind. Research* 9: 265–276 (1936).
7. Campbell, W. B., *Pulp Paper Mag. Can.* 52, No. 3: 217–220 (Convention, 1951).
8. Jayme, G., and Grögaard, L., *Cellulosechemie* 18, No. 2: 34–48 (March/April, 1940).
9. Jayme, G., and Grögaard, L., *Papier-Fabr.* 38, No. 17: 93–96; No. 18/19: 101–108; No. 20: 113–116 (April 26, May 10, 17, 1940).
10. Jayme, G., and Wettstein, R., *Papier-Fabr.* 36: 519 (1938).
11. Nolan, W. J., Harvin, R. L., Reeder, L. M., and Rothrock, C. W., Jr., *Tappi* 34: 529–538 (1951).
12. Longren, V., *Paper Trade J.* 113, No. 11: 119–122 (Sept. 11, 1941).
13. Hägglund, E., "Chemistry of Wood," page 449, New York, N. Y., Academic Press, Inc. (1951).
14. Hägglund, E., *Papier-Fabr.* 34, No. 34: 313–319 (Aug. 23, 1936).
15. Hägglund, E., *Svensk. Papperstidn.* 41: 194(1938).
16. Green, H., and Yorston, F. H., *Pulp Paper Mag. Can.* 41: 123–126 (Feb., 1940).
17. Anderson, C. A., *Pulp Paper Mag. Can.* 47, No. 1: 43 (1946).
18. Bildt, O., *Svensk. Papperstidn.* 41: 261 (1938).

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The Rheology of Cooked Wood*

II. *Effect of Temperature*

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A study has been made of the effect of temperature on (1) load to failure, (2) percentage deformation at failure, (3) work to failure, of yellow birch subjected to a radial shear. The wood was heated oven-dry in oil or water-swollen in sodium bicarbonate solution. The temperature range was room to 205°C. for oil, and room to 185°C. for the aqueous system. Specimens were tested at the elevated temperatures and also after cooling. Photomicrographs were obtained of the plane of failure. Results indicate that for oven-dry wood in oil, no strength is lost by heating and cooling, but when tested hot, there is some strength lost at the higher temperatures. The percentage deformation at failure increases with temperature as does the work to failure. In the aqueous system there is a very considerable loss in strength over the temperature range 80 to 120°C. The percentage deformation at failure shows a maximum at 90°C. and a minimum at 140°C. The work to failure decreases with increasing temperature. The microscopic study shows wood in oil at room temperature to fail across a double cell wall from lumen to lumen; in oil at 205°C. the plane of failure tends to follow around cell walls between the cells; in the aqueous system at 25°C. there is much fibrillation of the outer surfaces of separated cells; at 120°C. in the aqueous system there is a much cleaner break but still some fibrillation; at 185°C. all the cells collapse under the shear force.

In the first paper of this series (*1*), a number of arguments were presented for finding the force required to break a piece of wood after it had been pretreated in various ways. The broken surface was to be examined microscopically to see if the anatomy of cell wall failure could be distinguished and used as a criterion for the pretreatment most likely to lead to a satisfactory pulp. This paper describes the results obtained from experiments on the radial shear of birch at temperatures ranging from 25 to 180–210°C. and using a polar (water) and a nonpolar (oil) heating medium.

Remarkably little is known about the mechanical properties of wood at high temperatures. What little information there is was obtained under conditions which, in most cases, cannot be directly applied to pulping studies, being derived from work on kiln drying lumber or hot pressing wood to reduce its hygroscopicity, or other studies of this general nature. Because of their doubtful relevance, the various studies will not be reviewed here beyond summarizing them as follows. In general, an increase in temperature decreases the strength of wood and the effect is greater at high moisture contents than at low. This is true whether the wood is tested at the elevated temperature or after cooling. At high moisture contents the strength of wood after heating is very time-dependent because of decomposition. A brief review of this subject is to be found in a volume by Stamm and Harris (*2*).

Other work more pertinent to the present study is that on presteaming logs preparatory to grinding. A review of this subject has been made by Libby and O'Neil (*3*). In most cases the actual temperature of the wood at the time of grinding and the energy input of the grinder is not known; and because the steaming was usually done for sufficient time to lead to some solubilization of wood components, it is not possible to extract more information than the general conclusion that stronger pulp is said to be obtained from presteamed wood using less grinder power. In normal grinding practice it is found that an increase in grinder pit temperature (which must be related to the temperature actually existing at the stone-wood interface) decreases power input and increases pulp strength.

Probably the most pertinent data are those which have been obtained with the Asplund defibrator, plotting power input versus temperature, although even here the available information is much more scanty than could be desired. Longren (*4*) states that power consumption decreases linearly from 100 to 160–170°C. and then drops off sharply at higher temperatures. He says the drop in power is due to the softening of lignin in the middle lamella at around 170°C. Unfortunately no tables of data are given, although a graph showing this effect may be found in some of the Asplund manufacturers' advertising literature.

There seems to be a considerable need for more data in this field. High-yield processes based on fiberizing heated chips, grinding cooked logs, or even grinding cold logs, require a knowledge of the effect of temperature on fiberizing energy and pulp quality. It may vary with wood species, particularly between softwoods and hardwoods, with the kind and amount of chemical reaction which takes place prior to fiberizing, and with the kind of fiberizing force used.

In the present work it was decided to use a low rate of loading because it is easier experimentally and the results may be easier to interpret, an important consideration in exploratory work. It was desired to eliminate chemical reaction as a factor so the wood was heated in a sodium bicarbonate solution (pH 8.3) to provide an essentially neutral aqueous heating medium. A separate series of tests were carried out on oven-dry wood heated in oil. In this case the cell wall is not swollen and is therefore much stronger than when water-swollen, but the temperature effect still exists and if lignin melts at a certain temperature, it should

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be evident from the breaking force data and from microscopic examination.

EXPERIMENTAL

Apparatus

The apparatus designed for this work is shown diagrammatically in Fig. 1. It consisted of a stainless steel digester 6 in. in diameter and 12 in. long, inside which

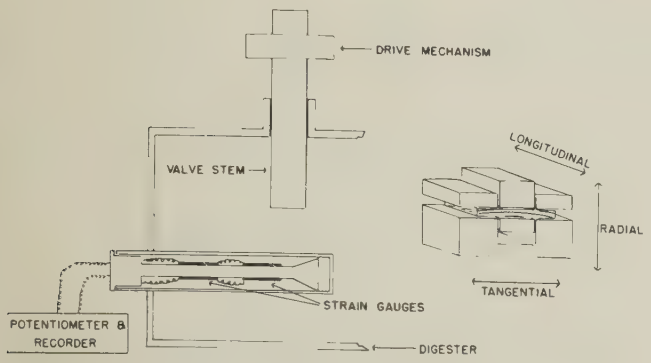

Fig. 1. Apparatus

was a load-applying and a load-measuring device. The load-applying device was a valve stem assembly removed from the valve body and welded to the top of the digester. (The digester lay with its longitudinal axis horizontal.) By means of a train of gears and a variable speed reversing motor, the valve stem could be raised or lowered at any speed over a fairly wide range.

Weight Sensitive Beam. The load measuring device consisted of a hollow stainless steel tube mounted as a cantilever beam in one end of the digester. This beam was 6 in. long and 13/16 in. outside diameter. It was able to withstand a load of over 100 lb. applied at its free end without exceeding the elastic limit. Inside this hollow beam another beam was fitted, square in section and containing four Baldwin SR-4 Type AB-1 strain gages bonded to the upper and lower faces by a bakelite resin. (At first the gages were bonded directly to the inside surfaces of the tubular beam, but it is rather difficult to produce adequate bonding in this way.) The gages were wired up in a normal Wheatstone bridge circuit using a d.c. voltage source and galvanometer as detecting instrument. With the arrangement as set up, a load of 100 lb. on the beam gave about a full-scale galvanometer deflection, and with 100 divisions, this represented a sensitivity of 1 lb. or 1% of full-scale deflection. Under working conditions it is probable that the precision was no better than 2%, but in view of the variability of wood itself and for the purposes of the study, this was considered quite adequate.

Calibration of Beam. The beam was calibrated by means of dead weights. The effect of elevated temperatures was obtained by using ethylene glycol as heating medium which permitted calibration at temperatures up to 180°C. with an open digester. The assumption was made that the pressures generated inside the digester when an aqueous solution was used above 100°C. would not change the sensitivity of the beam.

Operation of Digester

The digester was electrically heated and thermostatically controlled to 1°C. or better. The 4000-watt (maximum) heaters were capable of raising the temperature to 180°C. in 15 to 20 min. Circulation was provided by an external pump with 30 liters per min. capacity, and a cold water jacket on the circulating line permitted rapid cooling at the end of an experiment.

Choice of Strength Test

Many different strength tests are carried out on wood, but tension, compression, and shear are the purest and the ones most easy to analyze. Tension tests on wood are difficult to perform because the specimen tends to shear off in the jaws when the forces act parallel to the fiber axis or to split when acting at right angles to the fiber axis. Compression tests are easy to perform and will be studied at a future date, but a shear test was adopted for these experiments because they, too, are easy to carry out and, in addition, they produce a separation of cells rather than a buckling.

A shear force can be applied to wood either parallel to the fiber axis or at right angles to the axis (or intermediate positions, of course). When applying the force parallel to the fiber axis, it is difficult to find a shape of specimen which has the requisite ratios of whole-to-cut fibers, support area-to-shear plane area, and breadth-to-height. These difficulties do not present themselves in the case of loads applied at right angles to the fiber axis.

A shear force can be applied at right angles to the fiber axis to give a transverse, radial, or tangential plane of failure. The first was not considered because it would involve fiber cutting. The last was rejected because the plane of failure would select a path through the weakest part of an annual ring, probably the spring wood. A radial shear on the other hand cuts across an annual ring.

In practice, a strip of wood was cut from a log 2 ft. long, the strip being about 1 in. wide in the tangential direction and $^1/_8$ in. thick (about two annual rings) in the radial direction after planing. Pieces of various widths were then cut from this strip, the narrow ones being used for tests where high loads were expected (tests in oil) and the wide ones for the weaker specimens.

Wood Used

The wood chosen for this study was the sapwood of yellow birch, *Betula lutea.* This is a typical northern hardwood which is straight-grained, used in pulping, and can be cut and shaped very well with woodworking tools. Age of tree, 60 years; diameter, 9.5 in.; rings per inch, 12. The specific gravity of the wood on an oven-dry weight-swollen volume basis was 0.63. The wood was permitted to airdry to about 15% moisture (oven-dry basis) before cutting the specimens.

Specimen Holder

The details can be seen in Fig. 1. The bottom U-shaped holder rested on the sensitive beam and the load-applying device pressed down on the raised central section of the assembly. The wood was clamped rigidly in the holder so that when the central section was pressed down there was no possibility of the wood bending as a beam. Two radial shear planes were

Table I. Effect of Temperature on Radial Shear of Birch Aqueous System ($NaHCO_3$ Solution)

Specimen no.	Temperature, °C.	Load at failure, p.s.i. Hot	Load at failure, p.s.i. After cooling	Deformation at failure, % Hot	Deformation at failure, % After cooling	Ultimate stiffness, load/deformation Hot	Ultimate stiffness, load/deformation After cooling	Work to failure (per sq. in.), in.-lb., hot
78	25	560	...	31	..	18	...	14
79	25	540	...	33	..	16	...	14
80	59	500	...	47	..	11	...	16
81	81	383	...	51	..	7.4	...	14
76	100	258	...	51	..	5.0	...	9.0
89, 90	119	191	460	43	42	4.4	11	7.6
74, 75	120	126	450	41	39	3.1	11	4.0
82, 83	140	112	438	28	39	3.9	11	2.5
87, 88	140	137	430	41	40	3.3	11	4.6
72, 73	160	93	400	48	47	2.0	8.5	3.6
91, 92	170	80	410	43	44	1.8	9.3	2.7
85, 86	170	99	409	48	54	2.0	7.6	3.4
70, 71	186	65	217	50	58	1.3	3.7	2.5

formed in the spaces between the fixed and moving parts of the assembly. The clearance was 0.001 in., which is sufficient for the plane of failure to follow around and between fibers if it is so desired.

Rate of Loading

Impact loading, or at least high rates of loading, are usual in commercial fiberizing practice and will be studied in this series in due course. Very low rates were adopted for these first experiments because they are instrumentally very much easier to carry out. It was felt necessary to gather a considerable amount of background data under moderately simple experimental conditions before introducing the complications anticipated with the measurement of load-elongation data under impact conditions inside a small digester at high temperatures and pressures. Consequently a rate of loading of 0.024 in. per min. was adopted, this being the rate recommended by ASTM for small wood specimens. This rate was also found to be very suitable from a time point of view, the time to failure being in the order of 1 to 3 min.

Heating of Wood

Two series of experiments were carried out (1) oven-dry wood in oil, and (2) wood saturated with 1% sodium bicarbonate solution. For the oven-dry series, the wood was dried at 105°C. for 24 hr., evacuated, and flooded with a transformer oil. For the other series, the air-dry wood (15% moisture) was evacuated and flooded with 1% $NaHCO_3$ solution. The width and thickness of the specimens were then measured with a micrometer. One specimen was clamped in the assembly as shown in Fig. 1, and another put loose into the digester. The digester was then filled, heated to the required temperature as rapidly as possible (5 to 15 min.), and maintained at this temperature for 20 min. to insure that the wood had reached a uniform temperature. The specimen was then broken at 0.024 in. per min., the output from the strain gages on the sensitive beam being recorded continuously. The deformation of the specimen was calculated from a knowledge of the relative rates of travel of the recorder drive and of the load drive. A correction for beam deflection was applied.

After the specimen had broken, the digester was cooled to room temperature in approximately 40 min. The broken specimen was carefully removed from the clamp assembly and placed in a bottle of oil or sodium bicarbonate solution for a later microscopic examination. The specimen which had been in the digester during this heating and cooling cycle, but had not been broken, was now clamped into the breaking assembly and tested at room temperature.

Microscopic Examination

The wood which had been heated in sodium bicarbonate solution was soft enough to be sectioned after embedding. Those which had not been heated, and all the specimens obtained from the oil series, were too hard for sectioning. The oil specimens were extracted with benzene and then alcohol and water mixtures to swell the walls gradually. They, and the unheated sodium bicarbonate specimens, were then softened by boiling or by hydrofluoric acid treatment. They were embedded in paraffin or collodion following the usual solvent exchange procedure. Transverse sections were then cut 20 mu thick and stained with a haematoxylin and safranin stain.

RESULTS AND DISCUSSION

The results are given in Tables I and II and shown in

Table II. Effect of Temperature on Radial Shear of Birch Nonaqueous System (Oil)

Specimen no.	Temp., °C.	Load at failure, p.s.i.	Deformation at failure, %	Ultimate stiffness, load/deformation	Work to failure (per sq. in.) in.-lb.
56	25	1280	7.1	180	6.3
67	25	1420	7.5	190	6.7
69	25	1270	5.2	244	3.7
68	67	1200	6.7	179	5.1
66	72	1090	7.3	150	5.1
63	100	1130	9.2	123	8.4
55	110	1050	13.5	78	11.3
51	120	940	16.5	57	11.8
53	130	990	13.0	76	10.0
65	130	1010	11.5	88	9.0
42	130	1000	11.0	90	9.0
49	140	800	15.2	52	9.0
58	140	940	18.0	52	13.0
50	140	833	15.8	52	10.0
62	150	895	16.5	54	14.0
29[a]	150	1220	...	...	...
40	156	846	13.8	61	9.0
54	160	732	19.0	39	12.0
64	165	856	15.0	57	10.5
41	170	830	13.8	60	8.5
47	180	832	18.0	46	13.0
59	180	678	19.0	35	13.0
60	180	720	15.0	48	11.0
48	185	666	18.0	37	10.0
43	190	600	16.0	37	10.0
25[a]	193	1220	...	...	...
61	200	620	26.0	24	14.0
45	205	490	24.0	20	10.0

[a] Broken at room temperature after heating and cooling.

Figs. 2 through 8. Photomicrographs of the plane of failure of several of the specimens, broken at various temperatures in sodium bicarbonate solution and in oil, are shown in Plates 1 to 12.

It is not wished to read too much meaning into these results at the present time. Over 90 tests were made,

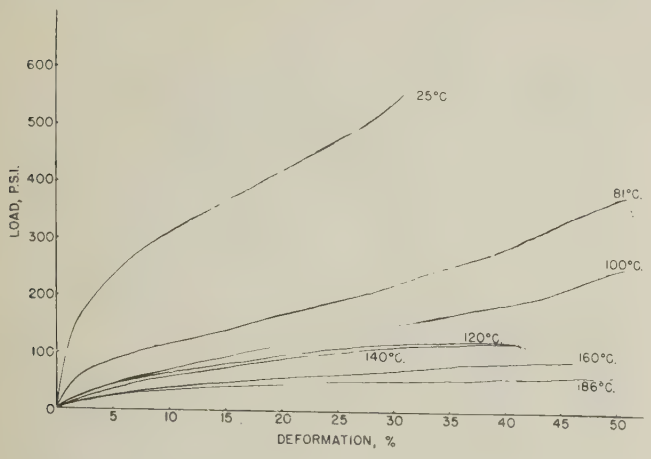

Fig. 2. Load-deformation for the radial shear of birch in an aqueous system at various temperatures. Corrected for beam deflection

but with wood being as variable as it is, and with a separate specimen being required for each point on a curve, it is necessary to be cautious in interpreting results. In addition to the doubts arising from wood variability, the equipment itself was open to some question insofar as measurement of wood deformation is concerned. This deformation was obtained by subtracting the beam deflection at any given load from

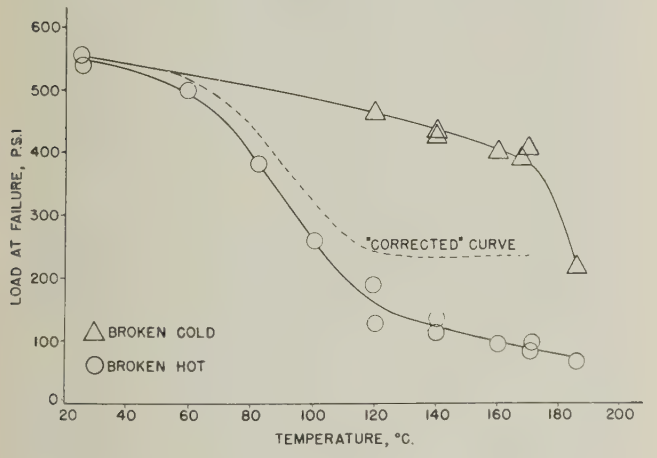

Fig. 3. Breaking load as a function of temperature. Aqueous system ($NaHCO_3$ solution)

the distance traveled by the loading mechanism (calculated from known rate of loading, 0.024 in. per min., and time scale on load recording instrument). For mechanical reasons (such as slippage between exterior sheathing beam and interior sensitive beam, which need not be elaborated upon here), this method of measuring the deformation of the specimen was subject to more error than the load measurements. Nevertheless, it is felt that the results are quite significant to draw a number of general conclusions and to establish a pattern of behavior for wood being broken at various temperatures under the conditions of the experiment.

Aqueous System

The load versus percentage deformation curves are given in Fig. 2 for a few selected temperatures. The load at failure is seen to decrease considerably with increasing temperature, while the percentage deformation at failure seems to be at a minimum at about 120 to 140°C. This is seen much more clearly in Figs. 3 and 4. In Fig. 3 the load at failure is plotted against the temperature for (1) specimens broken hot and (2) specimens heated, cooled, and broken at room temperature. The rate of strength loss with increasing temperature is seen to be greatest over the range 80 to 110°C., dropping fairly slowly over the range 120 to 185°C.

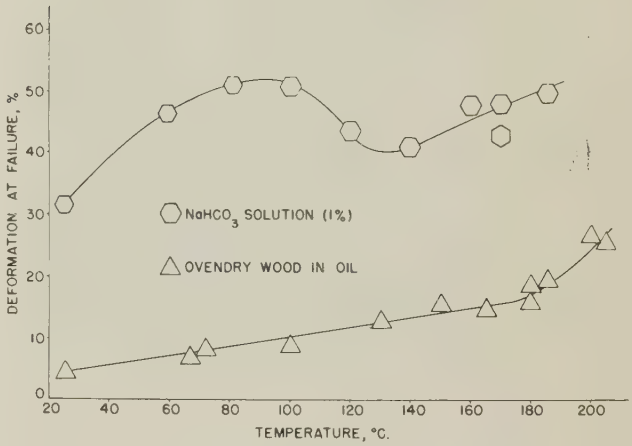

Fig. 4. Per cent deformation as a function of temperature. Aqueous ($NaHCO_3$ solution) and nonaqueous (oil) systems

There was no sign of an inflection in the neighborhood of 150 to 170°C., supposedly the softening range of lignin. At 185°C. the wood had only 12% of the shear strength at room temperatures. Wood that had been heated and then cooled before breaking did not lose its strength to anything like this extent, although at temperatures above 170°C. there was evidence of considerable strength loss. The wood darkened

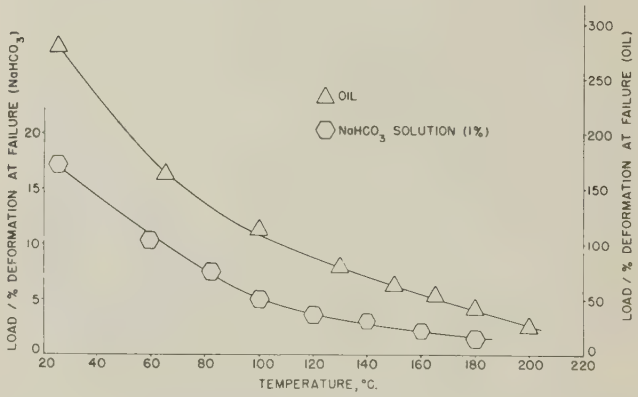

Fig. 5. Ultimate stiffness (load/per cent deformation at failure) as a function of temperature. Aqueous ($NaHCO_3$ solution) and nonaqueous (oil) systems

slightly above 170°C. so that evidently some decomposition was taking place to account for the large permanent loss in strength. Between room temperatures and 170°C. the slight loss of strength (550 down to 400 p.s.i.) obtained by heating and cooling may be accounted for on the basis of wood constituents going

into solution. These constituents would also have been dissolved from the specimens broken hot so that by adding the loss in strength due to dissolution (strength at 25°C. minus strength after heating to various temperatures, "cold" curve) to the strength actually found at elevated temperatures, a "corrected" curve is obtained (see broken line, Fig. 3) which should represent the strength loss due to temperature alone. This calculated curve is seen to fall to a minimum at 120°C. and then remain level until a temperature of 170°C. is reached. It appears possible that 120°C. represents an energy level which is just sufficient to rupture a group of bonds in the cell wall and reduce the cohesion between

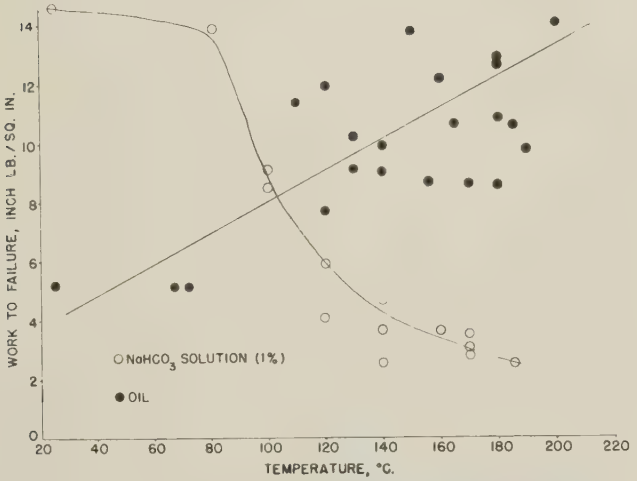

Fig. 6. Work to failure (area under Figs. 2 and 7) as a function of temperature. Aqueous ($NaHCO_3$ solution) and nonaqueous (oil) systems

certain elements of the wall to some fixed level. The addition of further energy, by raising the temperature from 120 to 170°C., has no perceptible effect on the

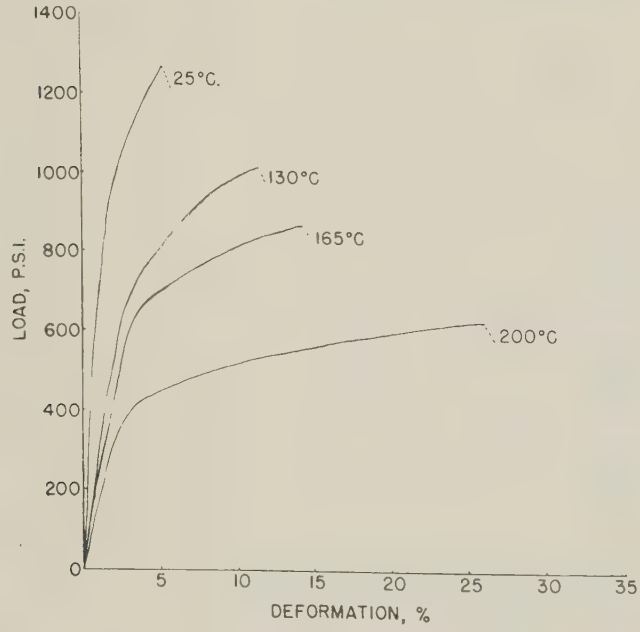

Fig. 7. Load-deformation curves. Corrected for beam deflection. Oven-dry wood in oil

cohesive forces in the wall. Above 170°C., as will be seen from the microscopic studies, a further softening takes place and the cells become very easily crushed.

The percentage deformation at failure in an aqueous system is shown as a function of temperature in Fig. 4. There is apparently a maximum around 100°C., and a minimum around 130°C. When the data for this curve are combined with that of Fig. 3, by dividing the deformation at failure into the load at failure, the curve shown in Fig. 5 is obtained. This is described as the "ultimate stiffness" and gives a measure of the stiffness

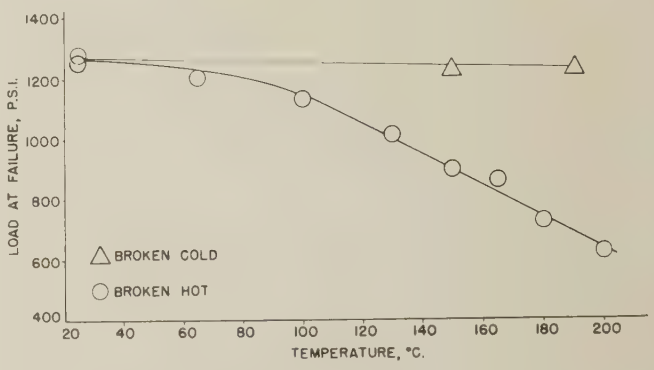

Fig. 8. Breaking load as a function of temperature. Oven-dry wood in oil

of the wood at various temperatures under the influence of shear forces. Because the shear forces act in such a way as to flatten the cells, the ultimate stiffness is similar to a measurement of hardness perpendicular to the fiber axis. The maximum and minimum of Fig. 4

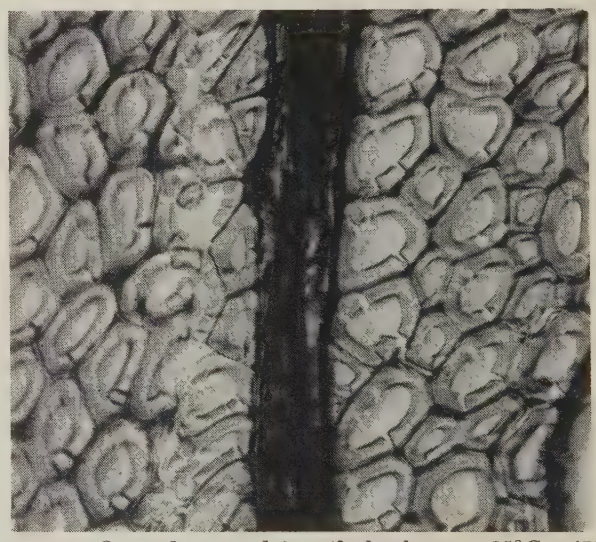

Plate. 1. Oven-dry wood in oil; broken at 25°C.; 475×

are eliminated in Fig. 5, and the stiffness of the material is seen to decrease steadily with increasing temperature, although flattening out somewhat above 120°C.

The shapes of the load-at-failure versus temperature curve (Fig. 3) and the percentage-deformation-at-failure versus temperature curve (Fig. 4) are not unlike the shapes of the curves obtained by Anderson and Berkyto (*5*) for the breaking stress versus relative humidity and percentage elongation at rupture versus relative humidity of a number of papers. At least a similarity exists if the range of 0 to 100% relative humidity is compared with the temperature range 25 to 120°C.

The areas under the load-deformation curves (Figs. 2 and 7) which represent the work required to cause failure, have been plotted as a function of temperature in Fig. 6. For the aqueous system the work appears to decrease with increasing temperature whereas for the nonaqueous system (oven-dry wood in oil) it appears to

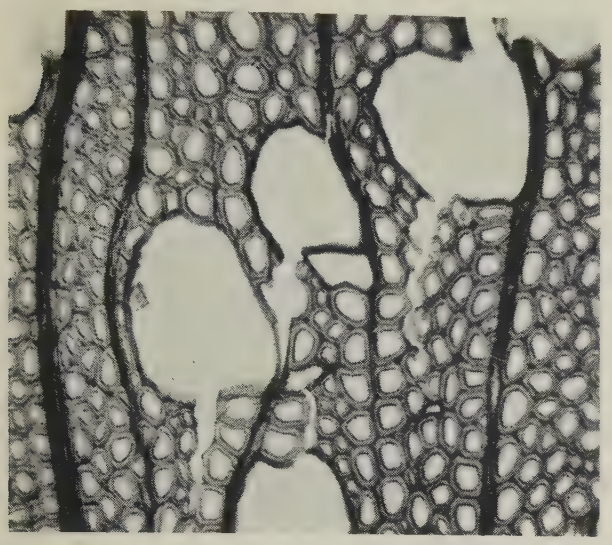

Plate 2. Oven-dry wood in oil; broken at 200°C.; 200×

increase with temperature. However, there is so much scatter of the points that discussion must be limited to the above observation.

Nonaqueous System

The oven-dry wood heated in oil behaved quite

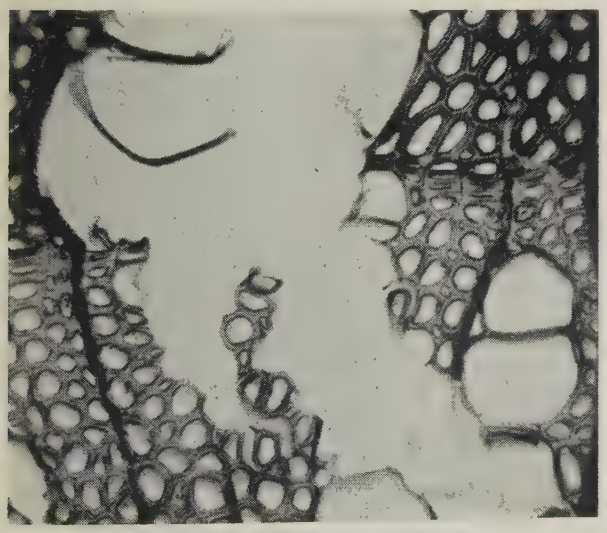

Plate 3. Water-saturated wood (1% $NaHCO_3$); broken at 25°C.; 200×

differently to the water-saturated wood as would be expected. The cell wall is unswollen and much stronger because of the absence of water bridges between the hydroxyl groups of neighboring cellulose chains—water bridges which provide "lubrication" and permit slip between chains in an aqueous system. Figure 7 shows the load-deformation curves at several temperatures and Fig. 8 shows the load at failure as a function of temperature. Wood that had been heated and cooled showed no loss of strength, even after heating to 190°C., but the specimens broken at elevated temperatures showed a considerable dependence of strength on temperature. There was no evidence of an inflection which might represent a lignin "melting point." The percentage deformation at failure, shown in Fig. 4, was much lower than in the aqueous system, and steadily increased with

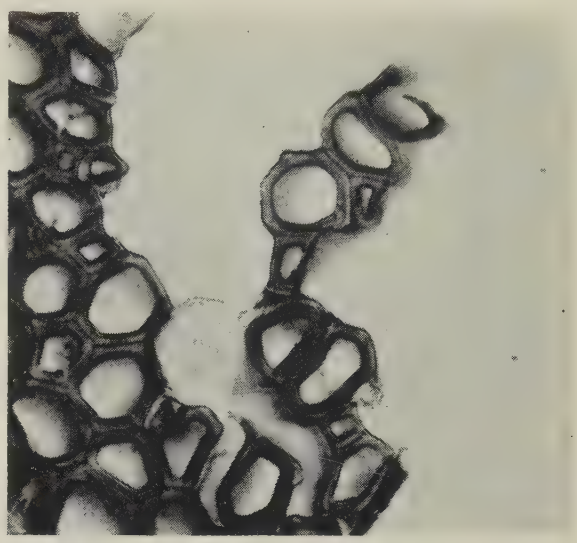

Plate 4. Water-saturated wood (1% $NaHCO_3$); broken at 25°C.; 400×

increasing temperature with no signs of the inflections observed in the aqueous system. The ultimate stiffness, shown in Fig. 5, appears to have a rather similar dependence on temperature as in the aqueous system, although the actual values in the nonaqueous system were more than ten times greater.

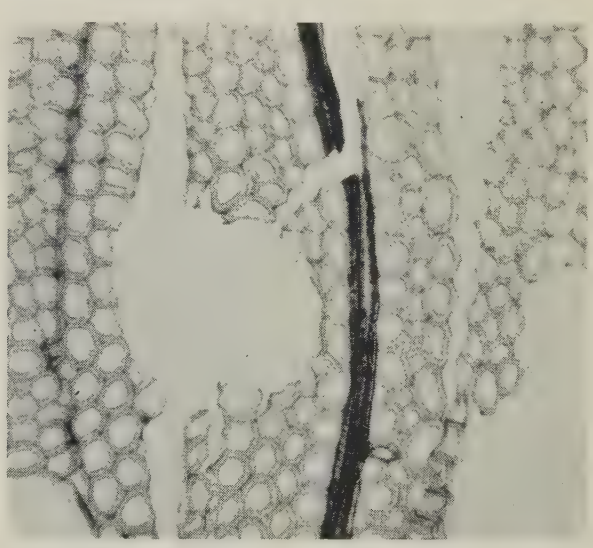

Plate 5. Water-saturated wood (1% $NaHCO_3$); broken at 120°C.; 200×

The work to failure, shown in Fig. 6, apparently increases with increasing temperature, in contrast to the aqueous system which is the reverse of this.

Microscopic Examination

It was hoped that a microscopic examination of the plane of failure would reveal whether the break occurred

in the middle lamella or in some layer of the secondary wall. These hopes were not fully realized, although distinct differences were observable in the character of the various fractures. In Plate 1, for example, which is oven-dry wood broken in oil at room temperature, it is clear that there was no tendency for the plane of failure to follow around a cell. The line of failure jumped from lumen to lumen across a double wall, leaving the two

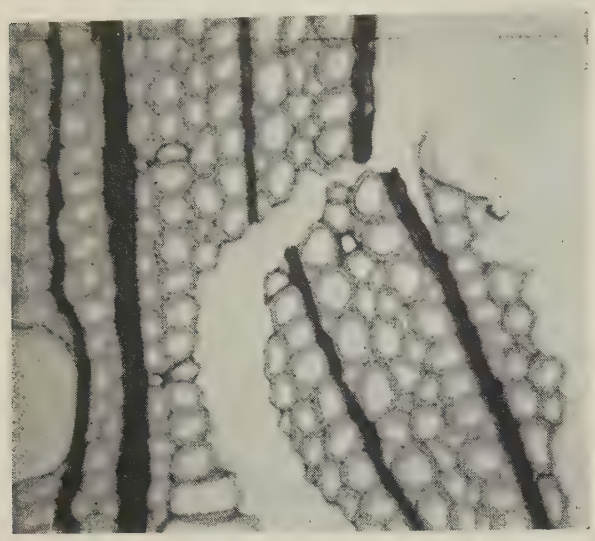

Plate 6. Water-saturated wood (1% $NaHCO_3$); broken at 120°C.; 200×

halves of the cell attached to opposite sides of the break. An attempt to fiberize wood under these conditions would obviously lead to nothing but cell debris. At 200°C. on the other hand (Plate 2) a number of cells did separate from one another with at least a partially intact wall. Other cells were broken across as at 25°C. It will be noted that the lower stiffness at 200°C. per-

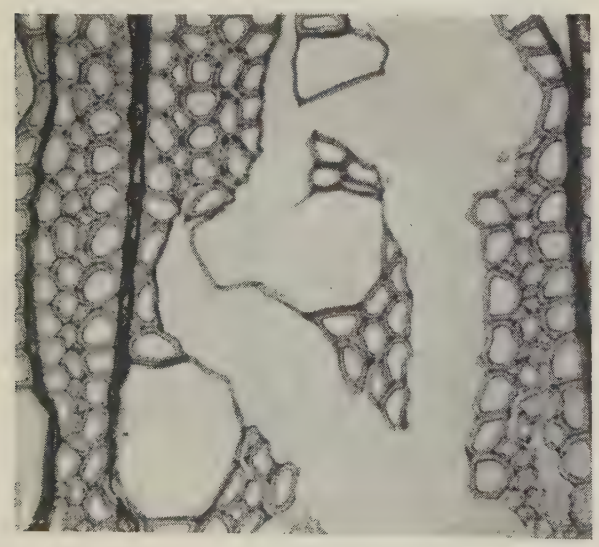

Plate 7. Water-saturated wood (1% $NaHCO_3$); broken at 120°C.; 200×

mitted a redistribution of load which resulted in a plane of failure at several locations.

In Plate 3 is shown the result of breaking in an aqueous system at room temperature. Most of the cells which have separated from their neighbors appear to have intact walls in the sense that the lumen has not been exposed, but the outer surface of these detached cells appears fibrillated and it is evident that the cleavage has not taken place in the true middle lamella.

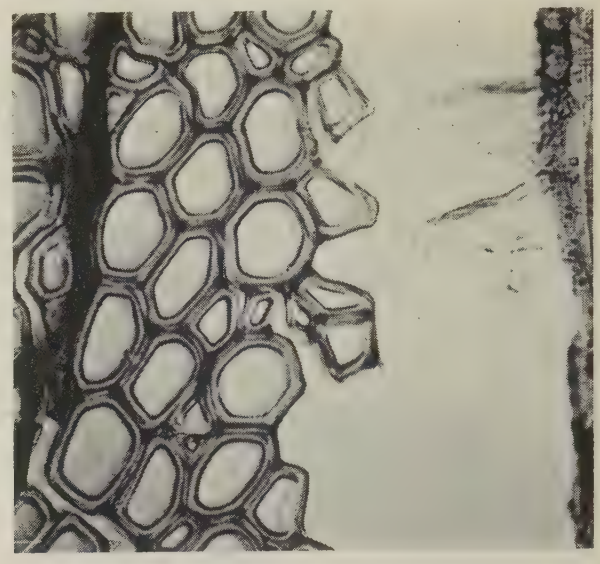

Plate 8. Water-saturated wood (1% $NaHCO_3$); broken at 120°C.; 475×

This is seen very clearly in Plate 4 which is a part of Plate 3 at higher magnification. The plane of failure occurred somewhere in the outer layers of the secondary wall of one cell, leaving the middle lamella, primary

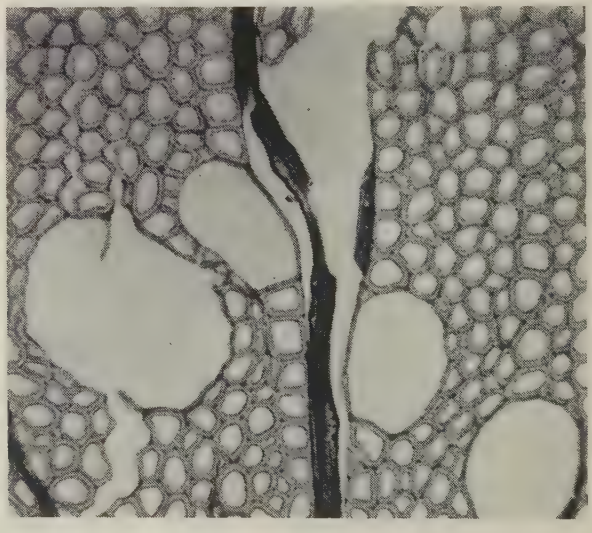

Plate 9. Water-saturated wood (1% $NaHCO_3$); heated to 120°C. and cooled; broken at 25°C.; 200×

wall, and presumably part of the secondary wall, attached to the intact neighboring cell.

Wood broken in sodium bicarbonate solution at 120°C. (Plates 5, 6, and 7) appears to have less cell wall damage than at room temperature although at higher magnifications (Plate 8) there is evidence of a separation of a layer from the wall. Wood heated to 120°C. but cooled before breaking (Plates 9 and 10) seemed to give an exceptionally clean plane of failure.

At 186°C. (Plates 11 and 12) there was extreme crushing of the cells with no true failure by shear.

From the above results it appears possible to draw a few tentative conclusions. In the absence of water, wood decreases in strength with increasing temperature,

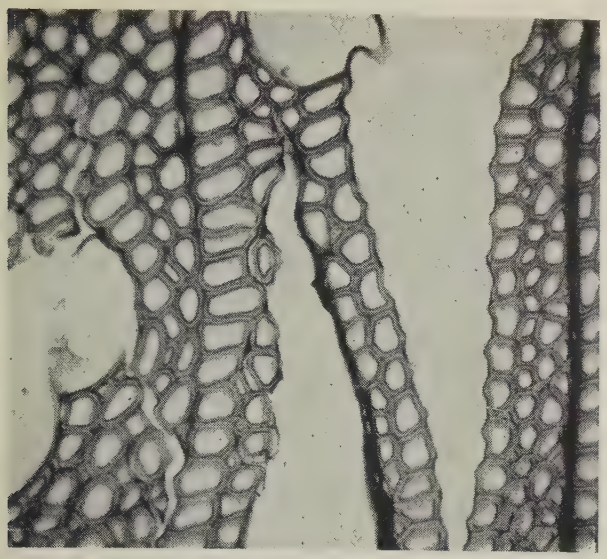

Plate 10. Water-saturated wood (1% $NaHCO_3$); heated to 120°C. and cooled; broken at 25°C.; 200×

but there is no sudden drop to correspond with a softening range of any wood component, and all the strength is regained when the wood cools. The percentage deformation at failure increases with increasing temperature, particularly above 170°C., and the ultimate stiffness shows a very considerable decrease.

In an aqueous system the wood is very much less

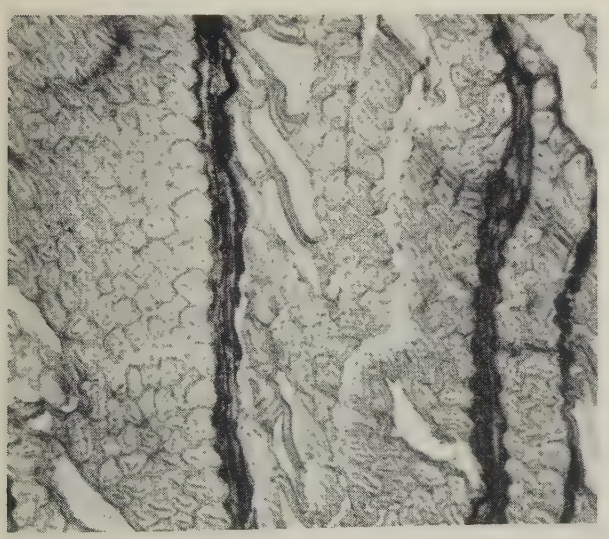

Plate 11. Water-saturated wood (1% $NaHCO_3$); broken at 186°C.; 200×

resistant to shear and to deformation than in oil, and the ultimate stiffness is actually less in water at room temperature than in oil at 200°C. The shear strength in water decreases very rapidly over the temperature range 80 to 120°C. If the effect of the dissolution of wood components is accounted for, there appears to be no change in shear strength over the range 120 to 170°C.

Microscopic studies suggest that at 120°C. where the shear strength is about 25% that at room temperature, the plane of failure tends to lie between cells rather than through them. The plane probably lies within the outer layers of the wall. The rigidity of the wall is sufficient to prevent collapse of the cells. At 186°C., on the other hand, the rigidity of the wall had been considerably reduced and there was evidence of collapse of all the cells under the influence of the applied shear forces.

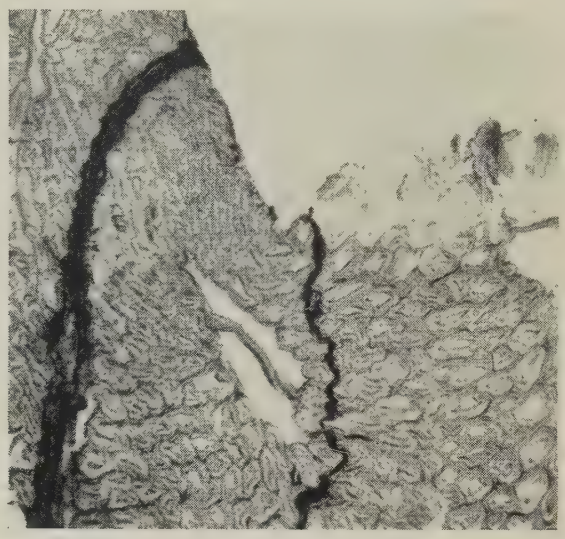

Plate 12. Water-saturated wood (1% $NaHCO_3$); broken at 186°C.; 200×

Possibly the loss of shear strength occurring over the 80 to 120°C. range involves the weakening of bonds between carbohydrate components of the wood, permitting slip between micelles, whereas at 170°C. and over the lignin begins to soften and lose its power of imparting rigidity to the wall, permitting collapse. If this is the case, then the use of elevated temperatures alone, with no removal of lignin, does not seem to be a suitable method for treating wood if intact fibers are required. On raising the temperature the carbohydrate bonds weaken first, and when a temperature is reached where the middle lamella lignin might be expected to soften, the cell wall collapses. This is at low rates of loading. The situation might be different under impact conditions.

If some cell wall fibrillation can be tolerated, then heating to 120°C. before fiberizing would seem to be as satisfactory as heating to 170°C. (always bearing in mind the conditions of these experiments—rate of loading, wood species used, direction of loading, etc.).

So far as energy consumption is concerned, it would appear beneficial to fiberize wood hot rather than allow it to cool first.

LITERATURE CITED

1. Stone, J. E., *Tappi* 38: 449–451 (Aug., 1955).
2. Stamm, A. J., and Harris, E. E., "Chemical Processing of Wood," Chapter V, New York, Chemical Publishing Co., Inc., 1953.
3. Libby, C. E., and O'Neil, F. W., Tech. Publ. No. 72, Bull. N. Y. State Coll. Forestry (1950).
4. Longren, V., *Paper Trade J.* 113, No. 11: 119–122 (Sept. 11, 1941).
5. Anderson, O., and Berkyto, E., *Svensk. Papperstidn.* 54: 441–444 (1951).

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The Printing Gage

H. J. CONNELL

The construction of and the procedure for operating a device known as the printing gage is discussed herein. The gage is used to print an ink film of varying thickness on the paper to be tested. Use is made of the fact that thin films set more rapidly than thick films and that the picking stress on a printed sheet varies inversely with ink film thickness. It is demonstrated that accurate measurements of printing characteristics, such as paper picking resistance, are possible with this instrument. The importance of and the variables affecting these printing characteristics are covered in detail. A series of figures provide a graphical representation of the operating procedure and results obtained with the gage.

THE name, printing gage, may be somewhat misleading in that it implies that here, at last, is a yardstick with which printing can be measured. The quality of a piece of printed matter, however, depends upon a multiplicity of variables beginning with the copy, the making of the plate, and down the line to the ink, paper, press, and even the state of mind of the pressman running the job. The gage will not measure all these influences but will give some valuable information about certain paper and ink characteristics that are prime factors in printing.

DESCRIPTION OF GAGE

Some may be familiar with the National Printing Ink Research Institute Grindometer for measuring the fineness of grind of printing inks. The gage to be described is simply one of these instruments modified to fit into the bed of a printing press.

Figure 1 shows top and side views of the gage which consists of a type-high metal block with two 6 by 1 in. grooves machined into its top surface. These grooves vary in depth from zero to 0.001 of an inch. They are actually inclined planes in that the depth continually increases from the shallow end to the deep end.

A series of marks on the block adjacent to the grooves indicate the depth at any point. There are ten of these marks—one for every ten thousandth of an inch of groove depth.

Figures 2, 3, and 4 show the gage installed on the press: Fig. 2 shows the press; Fig. 3, the gage locked in the bed in the conventional manner; and Fig. 4, a close-up view of the gage.

To print with this tool a dab of a standard ink is applied to the shallow end of one of the grooves, (Fig. 5) and then the groove is filled with a scraper blade (Fig. 6).

The gage inked and ready for printing is shown in Fig. 7. A wedge of ink is applied to a printing plate. At the shallow end, that nearest the quoin, the ink film is very thin, starting at 0.0001 in. and becoming progressively thicker until there is a relatively heavy film of 0.001 in. at the deep end.

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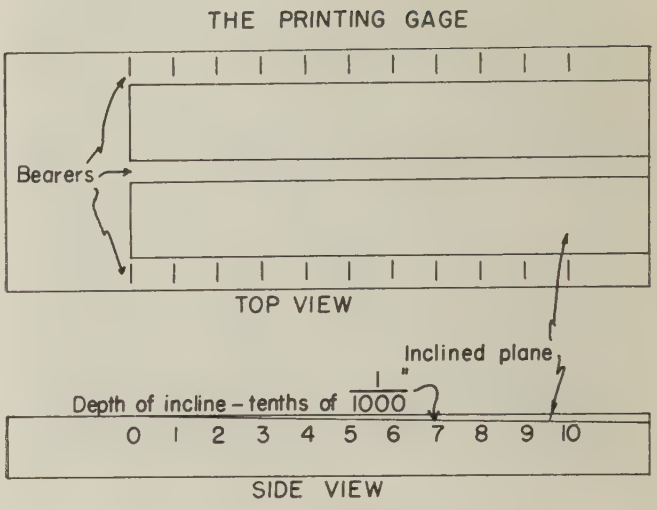

Fig. 1. Sketch of the printing gage

Gardner wet film thickness measurements of the amount of ink applied to a solid plate on production letterpresses have indicated an ink film thickness of from 0.0002 to 0.0004. Thus, the portion of the groove between 0.0002 and 0.0004 may be termed the average printing range. In the following discussion the various points along the gage will be referred to as steps. For instance, step five will indicate the point at which ink film thickness is 0.0005.

It is now possible to print a sheet with an ink film of varying thickness. Figure 8 shows the sheet coming in contact with the wedge of ink on the gage, and Fig. 9, the printed sheet.

INK SETTING TIME

Some years ago F. H. Frost observed that a freshly

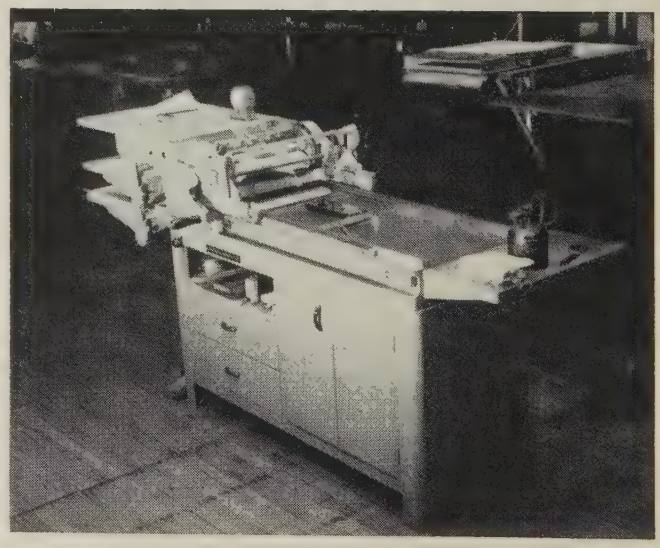

Fig. 2. The press

printed solid on coated paper would lose its wet glossy appearance after a certain time interval and become dull. The time for this appearance change could be expressed in seconds or minutes and the test was appropriately named ink setting time.

The graphical representation of ink setting time (Fig. 10) shows an ink film splitting to the surface of a

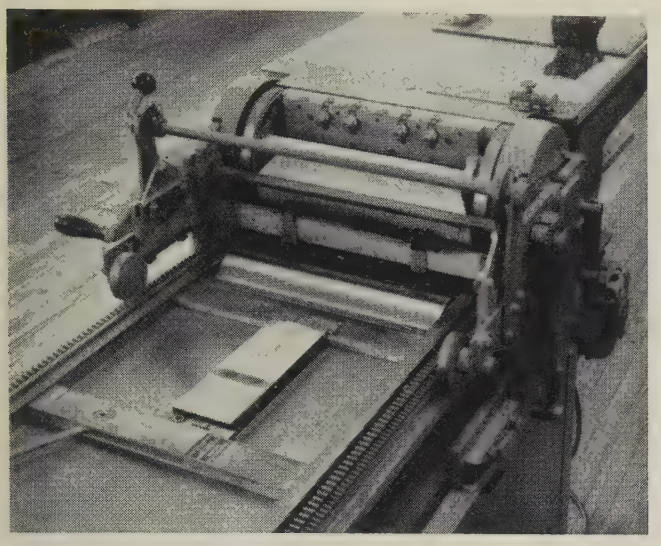

Fig. 3. Gage locked in the bed

coated paper. At the instant of impression, ink vehicle, represented by the cross-hatched area between A and B, commences to drain into the coating. The area between B and C shows the set ink film after excess vehicle has drained away. The time interval between A and B is the ink setting time.

Importance of Ink Setting Time

If the time from A to B is very long there will exist a tendency for printed sheets to block or offset in the pile. If the time is too short the vehicle may penetrate to

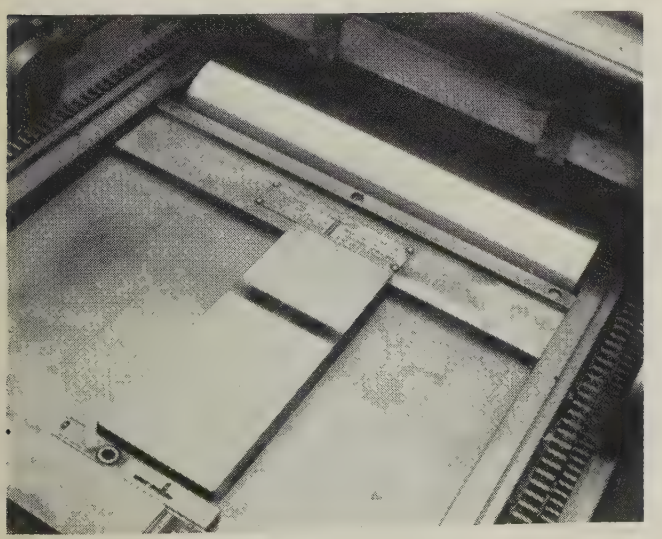

Fig. 4. Close-up view of gage

such an extent that the pigment is left high and dry on the surface resulting in poor rub resistance or even chalking.

On the other hand, for good gloss ink performance A–B should be long enough for gelation or drying to take place before much vehicle penetrates so that a continuous film may be formed over the pigment particles to give gloss.

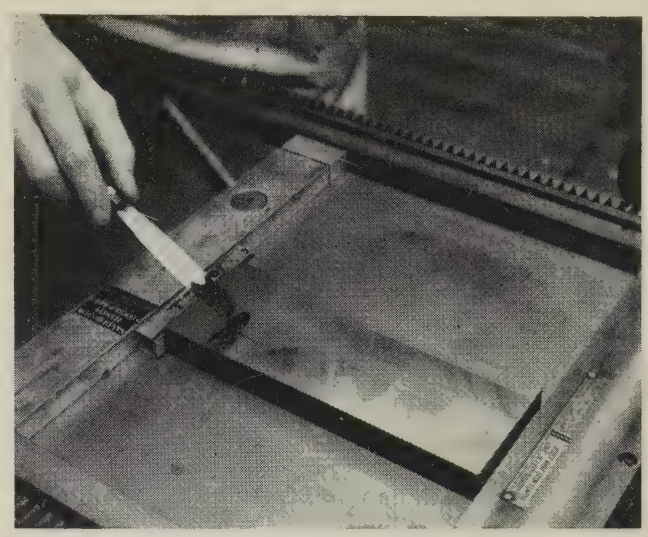

Fig. 5. Ink being applied

Thus it is quite apparent that ink setting time has a profound influence on the printed result.

Several methods, such as the K and N or Case ink test, have been offered as a means for measuring this ink-paper characteristic but all are somewhat lacking in accuracy and good numerical interpretation.

Frost's test, commonly called press ink setting time, has two major variables that are difficult to control: the amount of ink on the press has been observed to vary the readings considerably, and if any ink mottle is present as a result of uneven vehicle penetration it is difficult to determine when the ink has set.

Fig. 6. Ink being spread with a scraper

The printing gage eliminates these variables, thereby giving a quick, accurate measure of ink setting time.

Test Procedure

Here is the procedure for taking a measurement. Figure 9 will be recalled showing the sheet printed with the gage. This sheet has an ink film of varying thick-

ness. After a given time interval of, say, 60 sec. from the time of impression, a sheet of standard test paper is rolled into contact with the printed sample (Fig. 11). This standard test paper has a very flat glossy surface

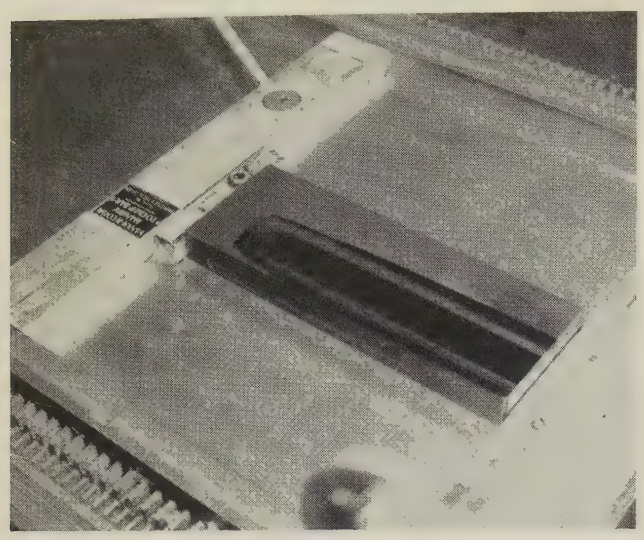

Fig. 7. Gage inked and ready for printing

of the cast-coated type that permits intimate contact with the printed sample. Any ink that has not set will be transferred to this top sheet to give a permanent visual record of ink setting time.

Note in Fig. 12 that the transfer indicates that the thinner portions of the ink film set rapidly because there is less vehicle, whereas the thicker films set more slowly and considerable unabsorbed ink is transferred to the sheet held by the operator.

Interpretation of Results

The transfers made from papers printed with the gage

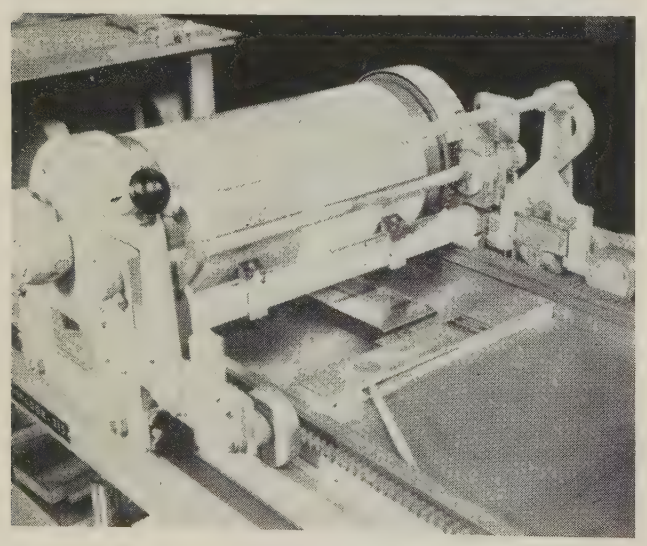

Fig. 8. Sheet coming into contact with inked gage

may be interpreted in units of time by either visual or numerical comparison.

The set of transfers shown in Fig. 13 was made from various coated papers after 60 sec. from the time of printing with the gage using a halftone black as the standard test ink. Number 1 represents a fast setting paper as evidenced by the fact that very little ink came off on the transfer paper. Transfer no. 7 however, was made from a sheet that really holds up the ink vehicle. Even the thinnest portion of the ink film has not set after 60 sec.

The gage works in a similar manner on plain papers

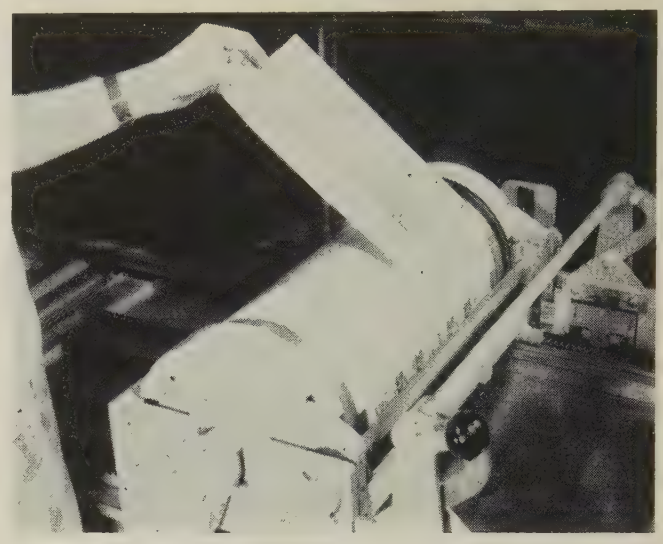

Fig. 9. Sheet being removed from press

(Fig. 14). Surface smoothness is an important factor here since a rough surface will not allow intimate contact by the transfer sheet. We are not too concerned, however, about actual values of ink setting time on plain paper except that it be as rapid as possible to avoid offsetting.

The following discussion is confined to coated papers.

The gage has been calibrated by taking a number of press ink setting time measurements and then printing the same sheets with the gage. It will be recalled that the press ink setting times are obtained by noting the time required for the freshly printed solid to lose its wet appearance and go dull. A large number of measure-

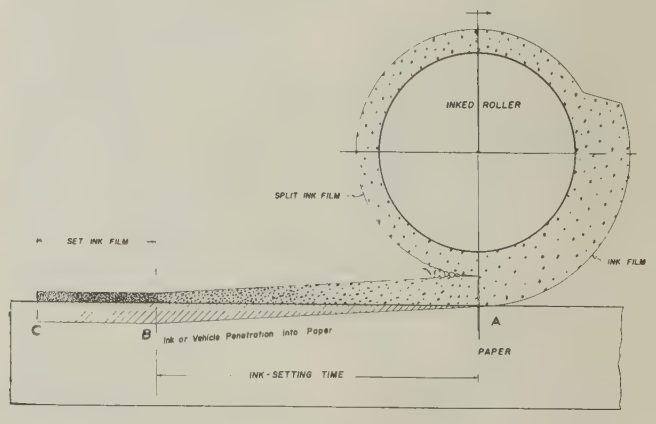

Fig. 10. Graphical representation of ink setting cycle

ments serves to minimize the errors inherent in the press ink setting time method. By making a set of transfers from several different types of coated paper after a standard time of 60 sec. after printing with the gage, a

set of standards was prepared. It was then possible to assign to each an ink setting time rating in seconds from the press ink setting measurements. Future transfers made from unknown papers may be compared to these standards and given an ink setting time rating.

For measuring very small differences in ink setting

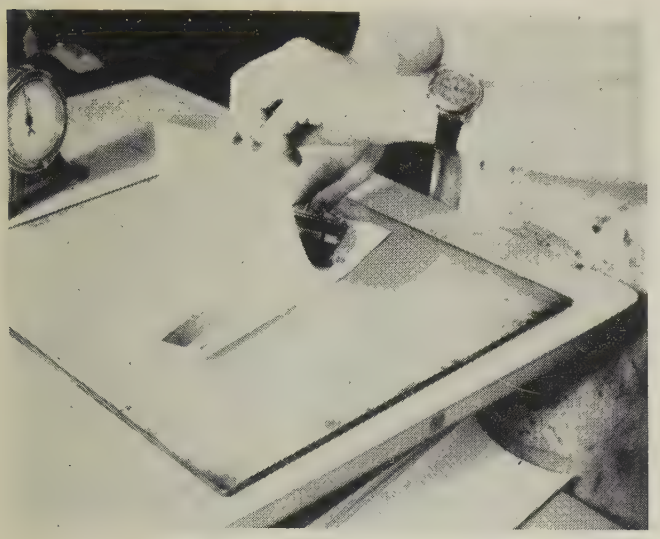

Fig. 11. Standard test paper being rolled into contact with printed sample

time it was decided that a direct numerical comparison with press ink setting time would be valuable.

Since the transfers are merely reflections of the unabsorbed vehicle, it was discovered that the light reflected at each step on the transfer would give an accurate picture of the ink setting characteristics of the sheet in question. In other words, a high reflectance reading would indicate very little ink transfer and a fast setting paper. Conversely, a slow setting paper would transfer a lot of ink which would result in a low reflectance reading.

Reflectance readings were taken with a Bausch & Lomb opacity meter at step four, which is in the aver-

Fig. 12. Sheet showing transfer pattern

age printing range, on a series of transfers and plotted against press ink setting times to provide a calibration curve. The meter was first adjusted to read 100% reflectance on the white transfer paper.

The curve of per cent reflectance at step four versus press ink setting time given in Fig. 15, makes it possible to express accurately the ink setting time of a sheet printed with the gage.

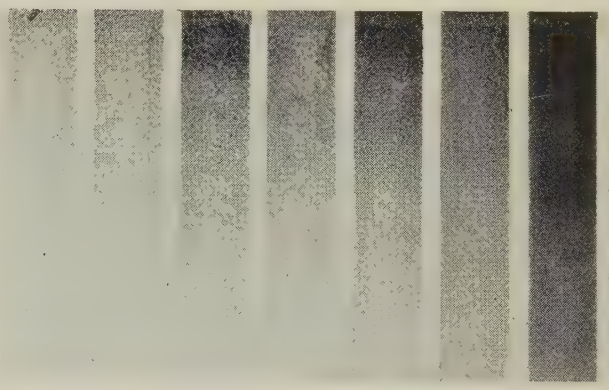

Fig. 13

By plotting per cent reflectance from 100 to 10 versus printing gage step number some interesting curves are obtained (Fig. 16). Note that the high curves are composed of relatively low reflectance values and indicate high ink setting time papers. The lower curves have fairly high reflectance values showing that very little ink was taken off by the transfer sheet due to a low ink setting time paper.

Several factors other than paper itself help determine the rate at which ink will set. Such factors must be appreciated when using the gage if the results are to be at all accurate.

Variables Affecting Ink Setting Time

The series of ink setting curves shown in Fig. 17 was made from transfers taken from the same paper printed with the same ink at different temperatures. Note that the highest curve is for the lowest temperature, 60°F., while the bottom curve represents ink setting at a high temperature, 107°F. It is apparent that the

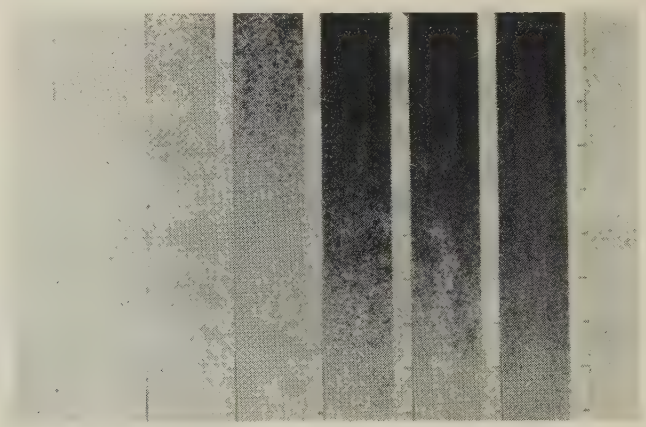

Fig. 14

higher the temperature the faster the ink will set. It follows that the use of heaters on a press delivery will often help on offsetting troubles but may hurt gloss ink performance.

A major factor that determines the readings obtained from the transfers is the time between printing with the gage and making the transfer.

The family of ink setting curves in Fig. 18 represents transfers made at different times after printing with the gage. Again the same paper and ink were used. Considering the top curve, which represents a transfer time of 30 sec., fairly low reflectance values are to be noted. This would be expected since very little ink

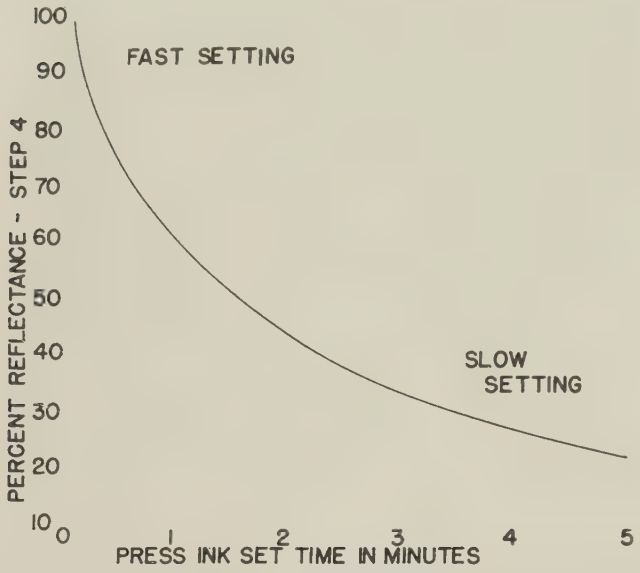

Fig. 15. Printing gage calibration with press ink setting time

has had time to set in 30 sec. on this particular paper. On the other hand, the bottom curve represents a transfer time of 16 min. Here, almost all the ink, even the heavier portions of the film, has set, as evidenced by very high reflectance readings.

In some instances, where a paper's ink setting time is very high or very low it is desirable to change this transfer time in order to read the result more easily. For example, transfers made after 60 sec. from 10 and 15-min. ink setting time papers will look almost identical—very long and dark. Hence it is necessary to use a longer transfer time, say 5 or 6 min., before a major difference in the transfers is observed.

Ordinarily, a transfer time of 60 sec. is used which gives an ink setting time range of from 1 to 300 sec.

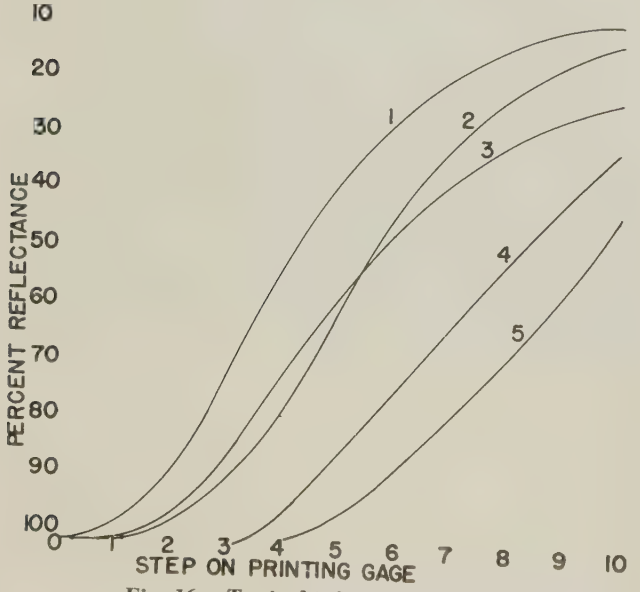

Fig. 16. Typical ink setting curves

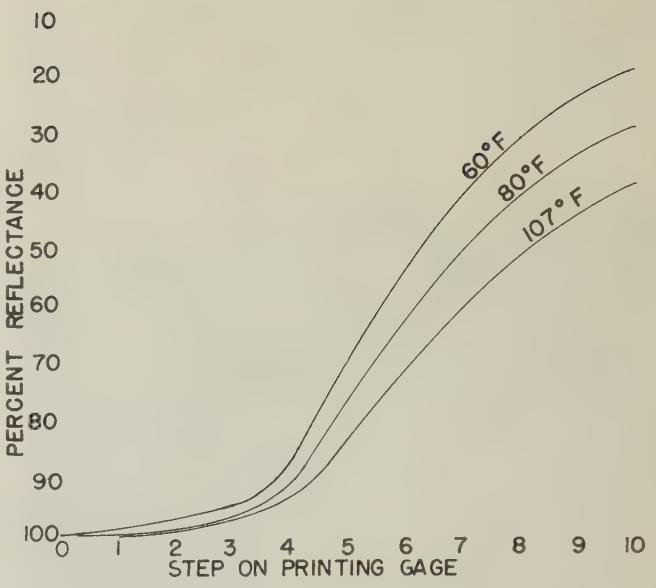

Fig. 17. Effect of temperature on ink setting time

The rate at which an ink vehicle penetrates a given sheet depends, to a large degree, on the nature of the ink.

It is possible, with the printing gage, actually to measure the ink setting time of different inks by printing on the same paper. Up to this point a halftone black has been used as the standard testing ink.

The curves shown in Fig. 19 represent the ink setting time of three inks on the same paper. The wide variation is due entirely to the nature of the ink. Note the high ink setting time of gloss black. In practice, gloss inks often give offset troubles unless a spray is used. The measurement predicts this tendency since it shows

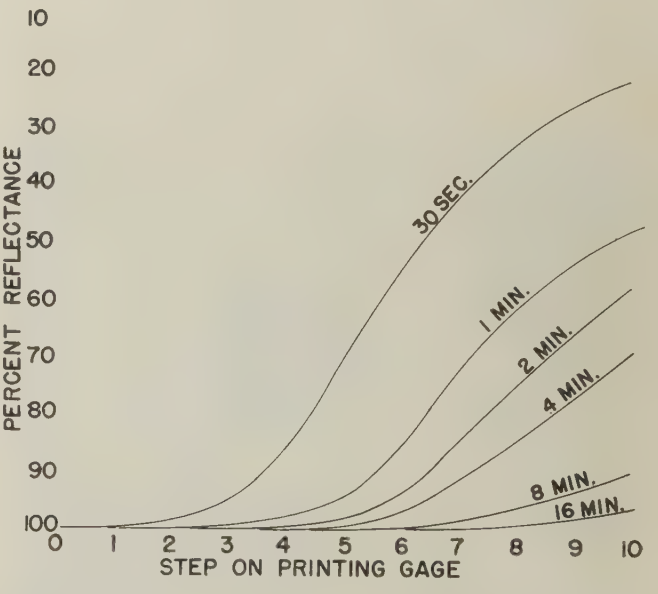

Fig. 18. Effect of time before transfer on ink setting time

a relatively large amount of vehicle remaining on the paper surface for a long time after printing.

The dull black, as represented by the bottom curve, exhibits extremely rapid ink setting time. Offsetting troubles are rare with a dull ink and the excellent mottle-free lay realized with this type ink points to rapid

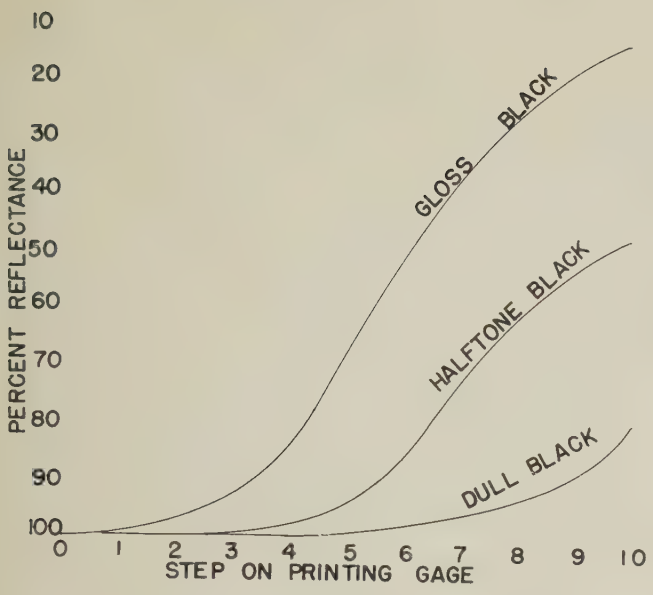

Fig. 19. Effect of ink on setting time

drainage of the vehicle into the paper. As compared to a gloss ink, the rub or scratch resistance usually leaves something to be desired, which indicates that less of the vehicle remains on the surface to bind the ink pigment to the paper.

Apparently, the halftone black, as shown by the middle curve, is a compromise between the gloss and the dull. This ink binds fairly well and gives reasonably flat mottle-free prints which permit fine halftone reproduction.

It is true that measurements made with the printing gage require somewhat more time and more careful interpretation than conventional press ink setting times.

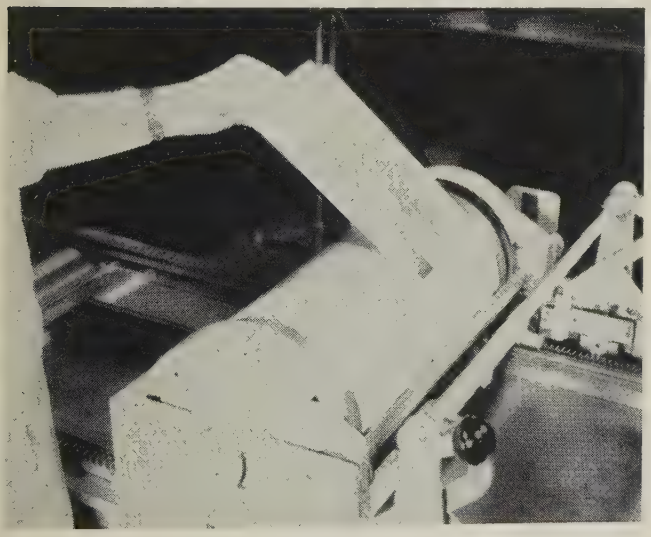

Fig. 20. Press and gage set to determine degree of picking

However, when very accurate results, detection of extremely small differences and a permanent visual record are desired, a better method is not known.

PICKING MEASUREMENT

Another helpful test that may be performed with the printing gage is the measurement of picking resistance or strength of coated paper.

The importance of paper strength in printing needs little discussion here for it is obvious that the paper must receive its impression without being pulled apart when the ink film splits.

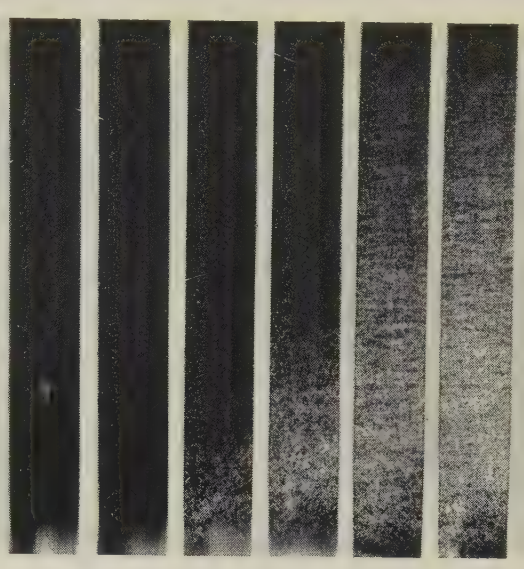

Fig. 21

Many types of pick testers have been devised. Probably the most well-known is the wax test, although in later years numerous mechanical devices have been developed to measure paper's picking resistance.

The author would like to describe the printing gage "pick" method for it makes it possible to test paper strength with an ink film of known thickness under dynamic conditions on the press. It also provides a visual record and a numerical figure indicating the degree of pick resistance.

Theory of Operation

It has been observed that the picking stress varies inversely with ink film thickness as long as ink coverage is complete. Therefore, when splitting a thin film from

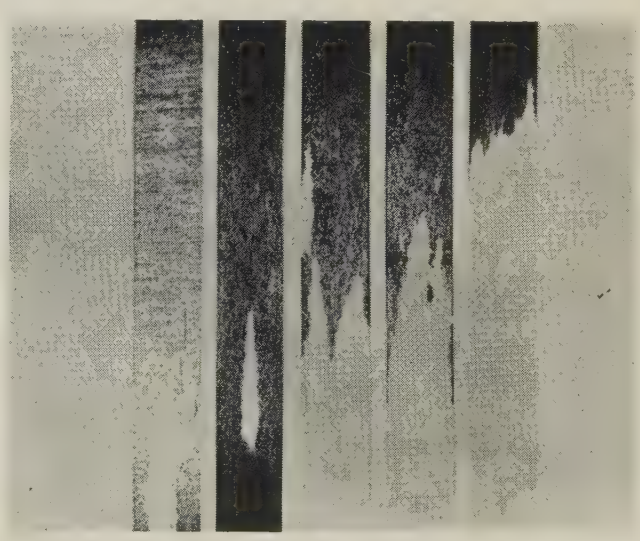

Fig. 22

a coated paper surface more force will be exerted on the coating than when splitting a thick film.

Also, inks vary in the resistance of their films to splitting, a property known as ink tack. High tack inks will be more likely to pick a given paper than low tack inks. Any tack figures referred to later in this discussion were obtained with the LTF Inkometer.

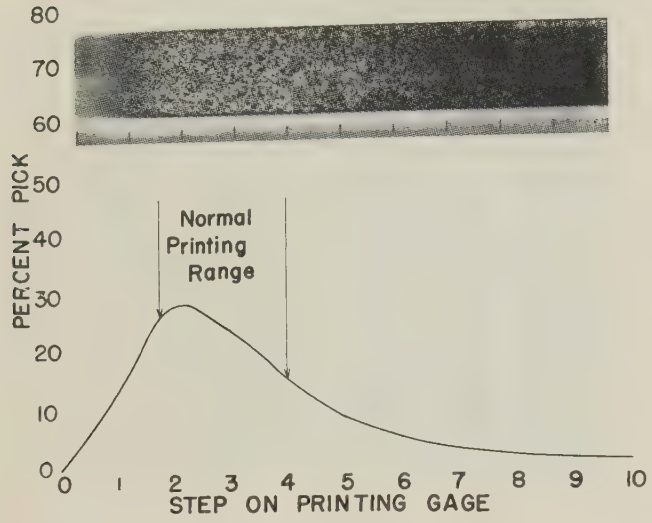

Fig. 23. Ink film thickness versus picking

Now, if paper is printed with the printing gage that sheet will be subjected to varying degrees of picking stress during just one impression. It will be recalled that the gage prints with an ink film of varying thickness.

Test Results

Figure 20 shows a fairly weak paper that has been printed with the gage. A very tacky offset ink was placed in the left hand groove and a moderately tacky ink in the right hand groove. The difference in degree of picking will be noticed.

The set of prints shown in Fig. 21 was made with the gage using the same ink. As can be seen, there are varying degrees of coating pick. Number 1 has strong coating while no. 6 has weak coating. Note that in each case the greatest per cent of picking occurs where

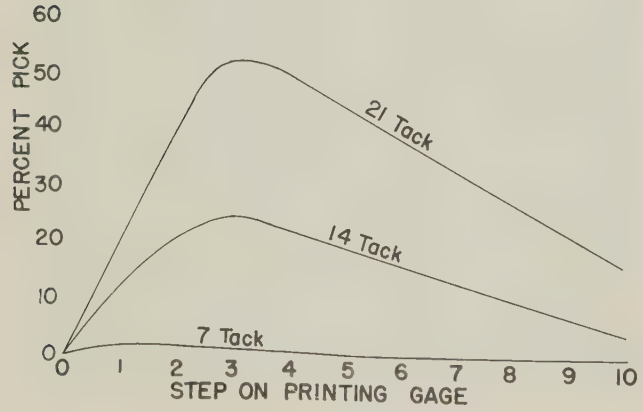

Fig. 24. Effect of ink tack on picking

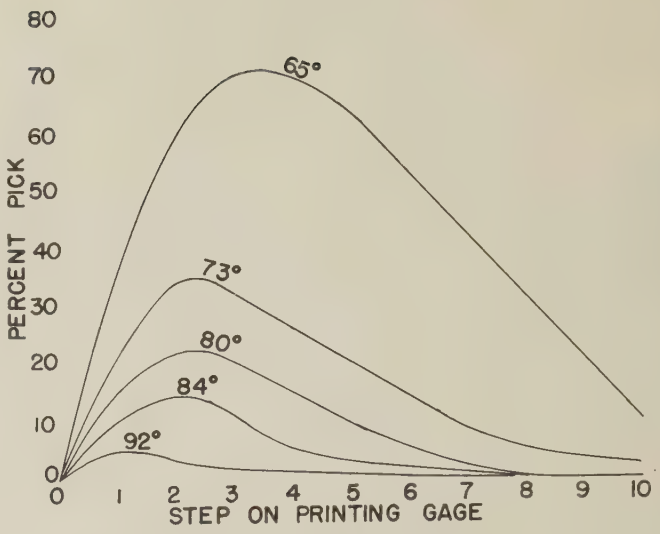

Fig. 25. Effect of temperature on picking

the ink film is thinnest or near the bottom of the samples.

Figure 22 shows varying degrees of bodystock failure. The coating was strong enough but the paper fibers pulled apart due to stress when the ink film split.

Expression of Results

If we have a coating pick the Bausch & Lomb opacity meter may be used to take reflectance readings at each step on the printed sample. In a badly picked area a high reflectance reading will be obtained since the black ink has been picked off with the coating leaving white paper.

Rather complete stripping of the ink takes place in bodystock failure so that the step number at which rupture starts will be sufficient for recording the measurement.

The reflectance readings obtained from a sample with coating pick may be expressed as the per cent of paper surface picked, and when plotted against the printing gage steps (corresponding to ink film thickness) the curve looks like that given in Fig. 23.

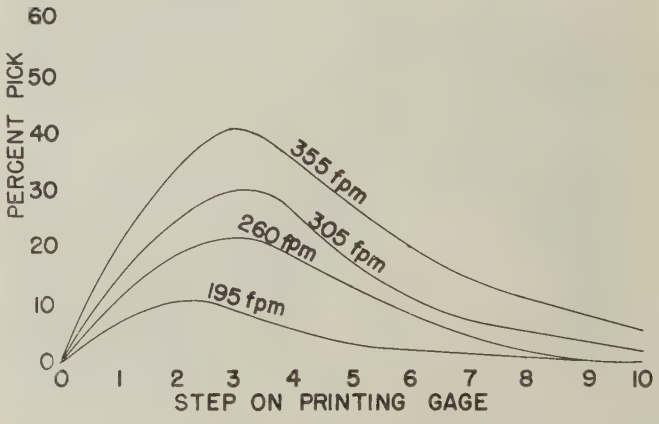

Fig. 26. Effect of press speed on picking

Per cent pick is plotted on the vertical axis from zero to 100% versus the printing gage step number from zero to 10 on the horizontal axis. The picked sample from which the readings were taken is shown above the curve. It is unfortunate that the greatest per cent pick occurs in the average printing range. However, this is the

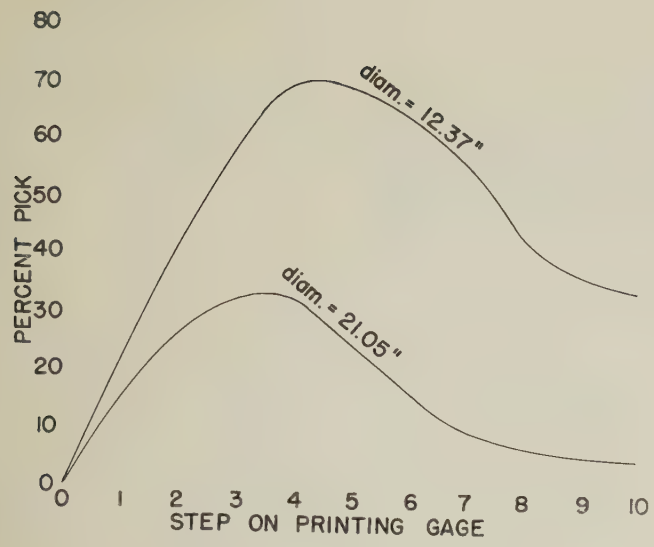

Fig. 27. Effect of press cylinder size on picking

point at which there is just sufficient ink film thickness to cover the paper surface. In expressing the pick rating for a given paper printed with a given ink under a given set of conditions, the maximum point on this curve is usually taken. Here the degree of picking is about 29% of the printed paper surface.

Factors Affecting Picking

As mentioned before, the property of ink known as tack or the force required to split a film of ink is one of the major factors in determining whether or not a sheet of paper will be picked during printing.

Figure 24 shows curves of per cent pick versus step number for samples of the same paper printed with the gage using three inks of different tacks. The bottom curve for a 7-tack ink represents the approximate tack range of a letterpress halftone black and shows about 2% pick; the middle curve is for a 14-tack ink which represents a typical offset black and shows about 24%

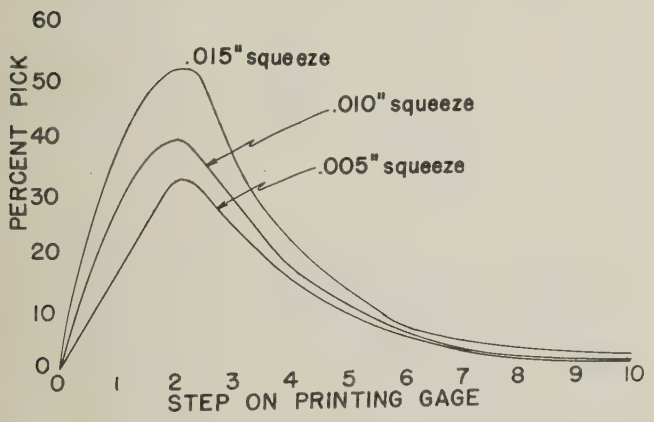

Fig. 28. Effect of printing pressure on picking

pick; while the top curve is for a 21-tack or very tacky offset ink and shows about 52% pick. These curves show the wide range of picking stress encountered by printing paper due only to the nature of the ink.

Temperature, also, has an influence on the degree of picking although it might be called a secondary influence for it affects the ink tack. Figure 25 gives a set of picking curves showing what happens to per cent pick when temperature is varied. The top curve for 65°F. shows 70% pick while the bottom curve for 92°F. shows 5% pick. This temperature difference is probably on the high side of what might be encountered in the average unconditioned shop. However, if the difference between 73 and 84° is taken an increase of over 20% pick for a temperature drop of only 11° is found, thus on a cold day a pressman might blame picking troubles on weak paper where actually the tack of his ink had increased due to a temperature drop.

It is apparent that both ink tack and temperature must be held constant if testing results are to have any meaning. Lacking good temperature control, a comparative evaluation of an unknown paper's strength may be made by running it along with a standard paper of known strength. This is possible since the two grooves on the printing gage permit two sheets to be printed at the same time.

Another important variable is the press speed. The picking curves shown in Fig. 26 illustrate the effect of press speed on picking, all other conditions remaining constant. It will be noticed that there is a 40% pick on the top curve for a press running at 355 f.p.m., whereas the per cent pick for the same press running at 195 f.p.m. is only 11%, as shown by the bottom curve.

As the speed at which paper is separated from the printing plate is increased, the rate of splitting of the ink film is also increased which subjects the paper surface to greater stress.

Press cylinder size helps determine the degree of picking since it also governs the rate at which an ink film splits. A cylinder of 12 in., as represented by the top picking curve shown in Fig. 27, makes for a rather high angle of separation of paper from plate, rapid film split, and a consequently greater degree of picking. Please bear in mind that a weak paper and a tacky ink have been used to point up these influences; it is not inferred that presses with small cylinders will necessarily give picking trouble. The bottom curve is for a cylinder of 21 in. in diameter, which lowers the angle of separation, slows the rate of film splitting, and reduces the picking tendency.

There is a relation between press cylinder packing and degree of picking stress as shown by the curves in Fig. 28. A heavy squeeze of 0.015 in. gives 52% picking in this particular case as shown by the top curve. If the impression is reduced to 0.005 in. the per cent picking drops to 34%. It is apparent that a smoother sheet that requires less printing pressure will be less likely to pick.

CONCLUSIONS

And so, in addition to making it possible to obtain visual comparisons and numerical readings of two important printing characteristics—ink setting time and picking—the printing gage helps to recognize many variables which affect these measurements as well as the end printed result.

It is believed it is a valuable tool to aid in predicting paper and ink performance on the press.

PRESENTED at the Fifth Coating Conference of the Technical Association of the Pulp and Paper Industry, Poland Spring, Me., May 24–26, 1954.

New Methods for Observing Properties of Paper which Influence Printability

H. H. HULL and M. C. ROGERS

New methods of paper testing are presented that should be useful to both papermaker and printer in showing differences in printing quality of paper. These tests show surface contour, absorption, and uniformity of the paper surfaces important to the pressroom. They are not complicated, are rapid and suitable for control work. The tests utilize "drawdown" techniques familiar to printing ink and finishes manufacturers.

Methods for estimating the printability of papers vary greatly, depending on the type of paper and on the experiences of the individuals concerned with the manufacture and use of paper. One common method is to print pictures containing a complete tonal range and to judge the results in comparison with those made on reference paper. Other methods involve the use of known physical tests such as gloss, smoothness by air leak methods, etc., and interpretation of them in terms of their correlation with printability from experience with one particular grade of paper. These latter tests are useful but individually limited because they measure only a small portion of the factors affecting printability. There are a number of factors influencing printability and it is very desirable that those which are real and important are established. We should not be concerned with properties of paper which happen to vary with printability because of some relationship in the papermaking procedures. When the methods of measuring them are established, printability ratings will be available for use by all sources of paper, the many grades of paper, and for the several different printing requirements.

The final criterion of printability is the printed result, and all methods for testing must be related by visual comparison to the printed result. As a research method this is necessary, but it suffers from the following uncertainties: (1) human judgment, including an "artistic appreciation"; (2) printing press conditions which are difficult to measure, evaluate, and specify either on a laboratory press or on a production press; (3) the prints do not usually identify the characteristics of the paper which cause printability variation; and (4) evaluations made in the normal course of production are slow and costly and they may result in objectionable variation in the quality.

DESCRIPTION OF TESTS

New methods are presented here which assist in visualizing the sources of differences in printability and offer explanation for many observed printing differences in commercial coated papers. The development of these methods was initiated by a comment during a discussion of printing problems: "Why cannot ink drawdowns be made on the paper on which the ink is to be used?" Drawdown techniques for ink inspection are well known, and it will be recalled that bond paper is used for making them, because the surface texture of this paper permits the drawdown knife to leave a thin film of ink on the paper surface suitable for color comparisons.

A quick demonstration was made of a drawdown using coated paper in which the authors were most interested. It happened that a rigid blade was used rather than a normal drawdown knife and that the paper was placed directly on a piece of plate glass. From the pattern obtained it was quite evident that the paper was characterized rather than the ink.

With this as a basis several tests were developed. They are modifications of the basic drawdown procedure, each made to amplify a paper characteristic associated with printability differences on the production presses. Although these tests were primarily developed by comparing coated papers which showed major differences in heatset printing, they indicate the properties of paper surface contour, and to some extent the absorption properties of the paper surface. They demonstrate the complexity of paper surface and explain how one test alone cannot be expected to characterize a paper's printability. From the practical viewpoint these tests are important in that they can confirm a pressroom report that papers are different.

There are four test methods described in this paper: (1) the rigid blade drawdown which shows paper formation and caliper variation; (2) the flexible blade drawdown which characterizes the coating surface; and (3) "wipe" tests which are essentially absorption estimates, giving some view of the "fine" character of the coating surface.

Rigid Blade Drawdown

Apparatus and Materials.

1. The rigid drawdown blade is shown in Fig. 1. It is adapted from a blade used on an ink "fineness of grind" gage. It is a straight but slightly "dull" blade of sufficient thickness to maintain rigidity. The edge of the blade has been ground and lapped to assure straightness.

2. The blade holder is shown in Fig. 2. It is a laminated plastic block, the important features of it being the pin for centering the weights over the blade, and an adjusting screw to assure maintaining the blade angle during testing.

3. The weights to lead this blade have a center hole to fit over the pin on the holder. One-half, two, and five-kilogram weights have been found adequate, to provide "printing" pressures.

H. H. Hull and M. C. Rogers, R. R. Donnelly and Sons Co., Chicago, Ill.

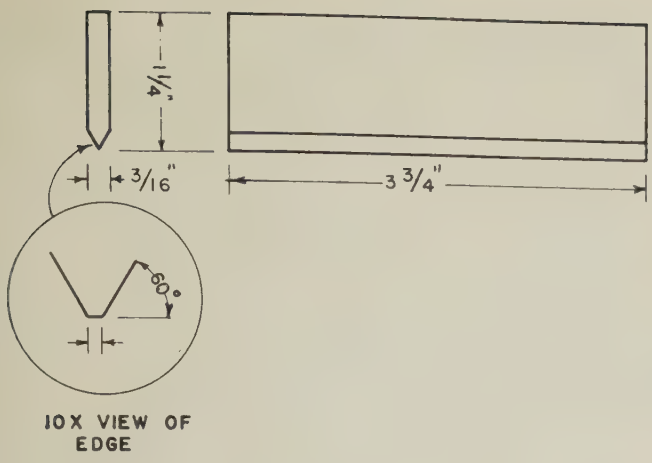

Fig. 1. Rigid drawdown blade for showing paper formation

Note: Width of edge of blade = 0.010 in.

4. A section of heavy plate glass about 1 ft. square and 1/2 in. thick is used for a test support but a larger area glass is much more convenient if large samples of paper are to be examined.

5. A specially formulated polybutene-base pigmented ink is used for these tests. It is short, nondrying, and of the correct pigment strength to show maximum differences in coated papers.

Method. The blade and plate glass should be checked for trueness by drawing the weighted blade over a small amount of ink on the plate glass, observing the uniformity of deposit. If the deposit is uniform the paper sample is placed on the cleaned plate glass and a drawdown made on the paper as shown in Fig. 3. It is desirable that the direction of drawdown be at about 45° to paper machine direction to emphasize marks parallel and cross direction to machine. Three seconds for 10 in. is a satisfactory rate of blade movement. When ink is to be added it has been found satisfactory to add it directly to the blade. The pattern obtained on the paper being tested will vary in darkness or lightness with the weight on the blade, the speed of the blade, and the angle at which the blade is held. These factors are not critical but should be duplicated for comparative tests.

The Flexible Blade Drawdown

Apparatus and Materials. A 0.004-in. "gravure" blade is mounted in the same holder used for the rigid blade drawdown. This blade extends 1/2 in. below the mounting.

The ink used in the rigid blade test may be used, but a special longer ink of similar formulation is easier to manipulate as the longer ink will flow down the blade and hence it has less tendency to run dry.

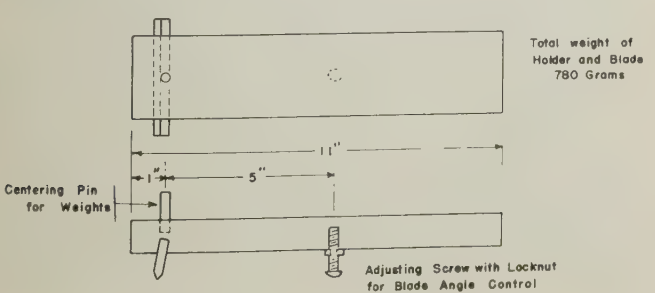

Fig. 2. Blade holder for paper-drawdown tests

Fig. 3. Method of making drawdown

Method. A sheet of "dental rubber dam" is placed on the plate glass, and the paper to be tested is placed on it.* The drawdown is then made with the flexible gravure blade in the holder. Either ink may be used, and the blade load being only the weight of the holder, or a 500-gram weight may be added. One inch per second is a suitable rate of movement.

The Wipe Tests

Three inks are used in these tests. They are the short and the long inks mentioned previously and another similar polybutene ink containing a soluble red dye for color instead of a pigment. Paper cleaning tissue of the type sold for home use is used for wiping. A smooth surface is needed for a paper support and the plate glass used in previous tests is suitable.

Method. The inks are "buttered" in a thin layer on the paper samples by means of a spatula. The inks are allowed to remain a specified time which may be zero time to 2 min. depending on the paper, and then removed by scraping off with the rigid drawdown blade or a spatula and then wiped dry with the cleaning tissues. For numerical comparisons, the color may be measured by use of a reflection densitometer. This neglects mottle which is often present in these tests, however.

The drawdowns and wipe tests produce patterns, as shown in Figs. 5 and 6, clearly indicating surface contours. Unfortunately they do not lend themselves to expression in a form similar to any now employed for other physical tests. They must be interpreted but this process is not objectionable or unduly difficult.

SIGNIFICANCE AND INTERPRETATION OF THE TESTS

The pattern shown by the rigid blade drawdown test (see Figs. 4 and 5) indicates the variation in thickness and hardness of the paper examined. Thin spots are dark and thick spots are light. In the course of development work using these tests, the writers have found that:

1. Caliper measurements of dark spots are lower than those of the light spots, and when drawdowns are made on opposite sides of the paper with red and blue inks (for identification purposes), the pattern is roughly duplicated on both sides of the paper.

2. It has been common to find that frequently when the printing impression is low, the broken printed areas

* Since this paper was written, some of the "dental dam rubber" obtained was found to vary greatly in thickness. Four or five sheets of high grade newsprint have been found to be a satisfactory substitute.

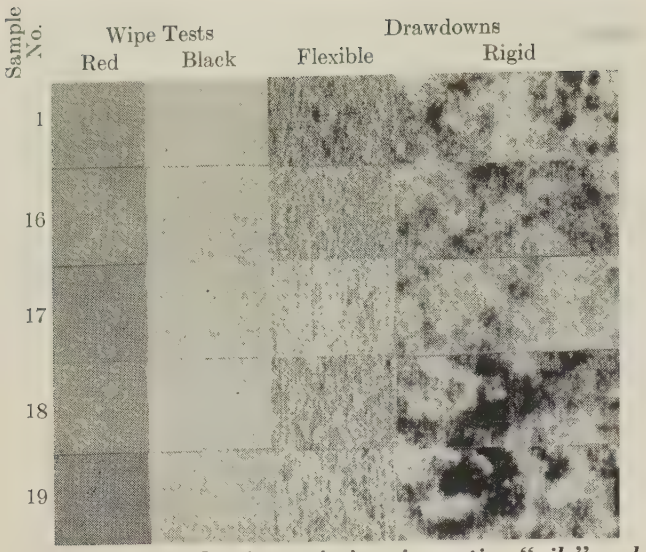

Fig. 4. Samples showing variations in coating "pile" and sheet formation

correspond to the low caliper spots as shown by the drawdown.

3. Carbon paper placed on the blade instead of ink will produce a similar pattern in which the high spots are darkened.

This rigid blade drawdown shows a surface contour apparently related to formation. It usually has a wavelength of 0.1 to 1.0 in. and as already stated, is a thickness variation duplicated on both sides of the sheet. Water and calender marks also show up on this test.

Surface irregularities and contour variations may be classified according to their size and frequency. The rigid blade drawdown differs from the flexible blade drawdown in wavelength or frequencies of the irregularity indicated. The flexible blade drawdown test shows a much finer pattern with usually no relation to the large rigid blade pattern, though occasionally fine detail in the rigid blade drawdown is related to that shown by this test. The drawdown pattern the authors have found in their experience with the flexible blade technique illustrates that: (1) coating "pile," holes in the coating, surface fiber structure, wire marks, and other similar characteristics which can be identified with low angle illumination are made more plainly visible by this test; (2) this test does not duplicate itself on both sides of the paper as is the case with the rigid blade drawdown; (3) the pattern may be removed immediately after it is formed by wiping indicating that the pattern is not caused by absorption properties.

An examination made by low angle illumination shows a similar pattern. None of the larger formation of the rigid blade is evident. Although the low angle illumination is a useful method, the translucency of the paper surface tends to hide some of the contour differences and variation in translucency of the surface materials can give the impression of being contour differences.

Some additional information about the printing surface can be obtained from the wipe tests which in a sense are a variation of the drawdown tests. The two wipe procedures are based on the concept that a test made with a pigmented ink indicates a roughness factor and a dye-base ink indicates a combination of roughness and absorption. In the authors' work all three of the inks have been found useful in making wipe tests and the results are somewhat different but the separation of roughness and absorption by these inks has not yet been proved, or even indicated clearly. Results from use of the rigid drawdown black ink and the red dye-base ink are somewhat similar. On one series of tests all on the same grade of paper they showed a high correlation with gloss, and a significant correlation with a quality rating of heatset printing results. This suggests that the roughness indicated by this test is of the same order as that which affects the gloss of the paper, though there are probably other related factors.

The wipe test with the long ink for the flexible blade drawdown frequently produces a pattern not found with the other two inks. This is usually a series of lines apparently related to some characteristic of the base stock.

The most frequently used wipe test is that made with the red dye-base ink. Red was chosen for this ink because the human eye is most sensitive to differences in amounts of red (i.e., minus green). This ink frequently produces mottle in the paper surface which appears to be as important a characteristic as is high or low coloration. Figure 4 shows examples of a "dark mottle" while Fig. 5, sample 1, shows an example of a "light mottle" which has been found in a few paper samples. Much more work is needed before any concrete ideas can be expressed relating to wipe tests generally, as they relate to printability.

Paper smoothness (surface contour) has long been known to be an important factor in printability. Few, if any, tests have found wide application in the coated paper field. The drawdown methods suggest that most of the smoothness tests supply information on only one character of contour, and hence they supply information which is incomplete. This criticism does not apply directly to the Chapman (*1*) or possibly, the printing tests (*2*). There is much literature on oil absorption of paper, but we have found no mention of tests which in-

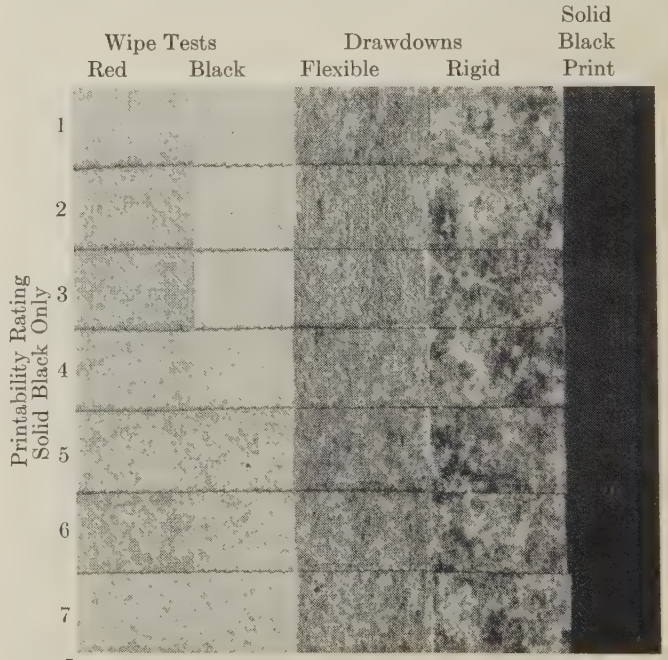

Fig. 5. Comparison of papers from the same supplier run successively on a production press

Table I. Classification for Type of Paper Surface Contour

Number	*Wavelength of irregularity, in.*	*Test method or indication of variation*	*Relationship to opposite side of sheet*	*Suggested name*	*Comments*
I	Over 1	Generally caliper measurements	Same on both sides	Caliper variation	Probably caused by variations in paper machine or calender
II	0.1 to 1	Rigid blade drawdown	Same pattern on both sides of sheet	Formation contour	This pattern appears related to the sheet formation. Sometimes lines are found parallel or perpendicular to machine direction. Calender marks evident
III	0.01 to 0.1	Flexible blade drawdown and low angle illumination	No relationship between pattern on opposite sides of sheets	Medium surface structure or contour	Coating pile, wire marks, fiber surface structure, holes, etc., all may be seen
IV	Less than above	Wipe tests	No relationship between opposite sides of sheet	Fine surface structure or contour	Finish and gloss as well as fine surface structure of the coating affect this method

dicate a pattern of absorption on the same sheet of paper. We suspect that most absorption tests are responsive to changes in surface contour similar to the wipe tests. Zettlemoyer and others (*4*), and West (*3*) have given reviews with extensive references on the subject of printability, and the significance of various physical tests on paper. They give a quick visual interpretation of differences between papers. Their disadvantages are that experience is required to interpret the results and that at present there is no complete numerical expression for them.

Figure 4 shows results from a series of roll samples of coated magazine paper run on presses at approximately the same time, and from one supplier. The quality of the printed result was varying widely and the variation was attributed to the paper. These samples were rated for printability by visual evaluation of the evenness and darkness of the solid blacks, and reproduced in the photograph. Wipe tests showed extreme mottle in the poorest printing papers. There is considerable variation in the flexible blade drawdowns with sample 3 showing the greatest "coating pile" while sample 1

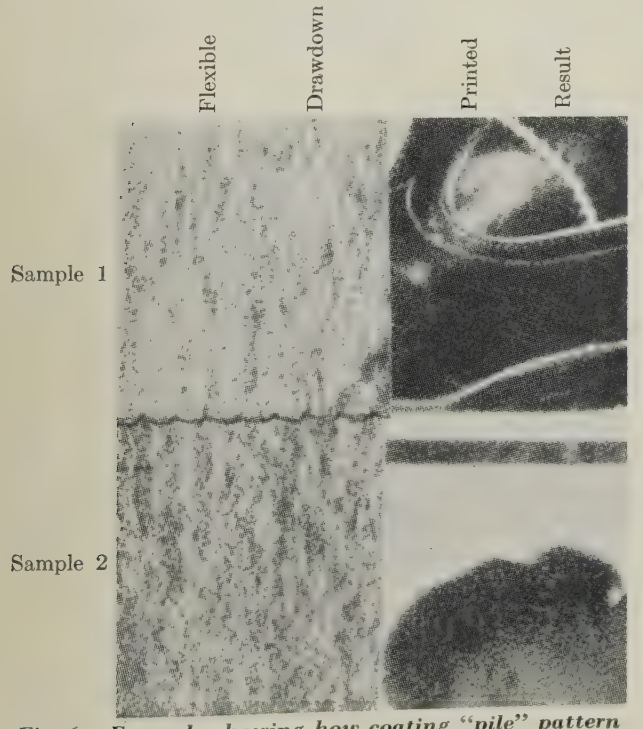

Fig. 6. Example showing how coating "pile" pattern can show in the printed result

Fig. 7. Flexible blade drawdown showing that a paper surface may vary greatly in a small distance

shows some lesser pattern in the rigid blade drawdown. It should be noted that the sample with the best printability shows minimum wipe mottle, minimum coating pile and a relatively good rigid blade drawdown. It is evident that the three qualities each influence the printability.

Figure 5 shows five samples of a heavily coated paper with large differences in the drawdown tests. Samples 18 and 19 have poor rigid blade drawdowns, with 17 the best. Sample 1 shows the poorest flexible blade drawdown pattern with coating pile evident in the rigid blade drawdown as well. A similar and somewhat related pattern also appears in the two wipe tests and is designated as "light mottle." Samples 17 and 19 show a minimum flexible blade drawdown pattern. Sample 17 should be the best printing of this group while sample 1 should probably be the poorest.

Figure 6 shows results from two samples of printing, and the flexible blade drawdowns on the same sheets of paper. Sample 2 print shows a typical formation of light gray spots which makes it difficult to obtain a good black. This sample has a more pronounced "coating pile" than sample 1. In Fig. 4, sample 3 shows the same type of gray solid print but it is not as clearly visible as in Fig. 6.

Figure 7 is an example of paper which varies greatly in roughness over a small area by the flexible blade drawdown. This illustrates how small area samplings for smoothness can lead to erroneous conclusions.

From the authors' experiences using the drawdown techniques it would appear that classification of types of paper by surface contour which has been developed is capable of giving the printer and papermaker means for estimating printability.

They may be of value to the papermaker in helping him to isolate his variables and control various phases of his process.

LITERATURE CITED

1. Chapman, S. M., *Pulp Paper Mag. Canada* 48, No. 3: 140 (1947).
2. Glassman, Alex, *Pulp Paper Mag. Canada* 53, No. 3: 178 (1952).
3. West, Clarence J., "Paper and Its Relation to Printing," Bibliographic Series no. 164, The Institute of Paper Chemistry.
4. Zettlemoyer, Fetsko, and Walker, *Tappi* 36, No. 2: 161A (1953).

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The authors wish to acknowledge the assistance they have received from Ray Stewart, O. R. Daum, and Alex Glassman. They have given us much practical evidence of paper differences and have made some of the first practical applications of these tests.

Ammonia for Control of Corrosion from Sulphate Turpentine

JOHN E. REESE

Corrosion caused by crude sulphate turpentine in tank cars and storage tanks has been successfully controlled by treatment with 0.25% aqueous ammonia. Corrosion rates on steel were reduced to 0.0005 i.p.y. or less. This reduction of corrosion appears to result from the maintenance of alkalinity in both liquid and vapor phases. Another effect is the formation of a surface film on the steel.

In an earlier article in this journal (*1*) it was shown that crude sulphate turpentine is very corrosive to mild steel. A simple treatment to control this type of corrosion was developed in our laboratories. This treatment consists of adding 0.25% of 28% aqueous ammonium hydroxide to the turpentine. This amount of ammonia is so small that it becomes completely dispersed in the turpentine. Corrosion appears to be inhibited by the maintenance of an alkaline medium (pH above 8) in both the liquid and vapor phase. Also the surface of the steel becomes coated with a very thin hard film which probably accounts for the resistance to corrosion. A very small weight increase often occurs on the steel test coupons indicating film formation.

This ammonia treatment has been applied to all tank car shipments of crude sulphate turpentine received at our plant during the past $2^1/_2$ years. After the tank car is emptied, 17 gal. of aqueous ammonia are added before returning the car to the paper mill for refilling. This is the minimum amount of ammonia which will maintain alkalinity at all times. Corrosion tests have been carried out in these tank cars, and the data obtained are given in the table. From these results it appears that corrosion has been successfully inhibited by ammonia treatment since all corrosion rates were less than 0.0005 i.p.y. The test coupons were placed in the empty cars at our plant, the vapor phase coupon being located in the dome and liquid phase coupon 3 ft. below the dome. The pH was determined on distilled water used to extract an equal volume of the turpentine.

In addition to these corrosion tests, visual inspections of tank cars were made at periodic intervals. No evidence of corrosion was observed which lends weight to our test results with the coupons.

The ammonia-treated turpentine received at our plant is pumped to steel storage tanks. Enough ammonia remains, even over long periods of time, to prevent corrosion in these storage tanks as shown by the last two tests in the table. Also visual inspection of these tanks shows that corrosion has been effectively prevented.

It is hoped that this experience in the use of ammonia to inhibit corrosion will be helpful to others having similar problems in the transportation and storage of crude sulphate turpentine.

Table I. Corrosion Tests in Tank Cars Transporting Ammonia-Treated Crude Sulphate Turpentine

Tank car no.	*Duration of test, days*	*Area of coupon, sq. in.*	*Weight difference of coupon, gram*		*Corrosion rate, i.p.y.*		*pH of turpentine at end of test*
			in vapor	*in liquid*	*in vapor*	*in liquid*	
1	16	6.94	0.0085	0.0042	0.0002	0.0001	8.9
1	10	7.46	0.0073	0.0131	0.0003	0.0005	9.7
2	19	6.94	0.0014	0.0042[a]	Nil	0.0001[a]	9.2
2	13	6.94	0.0030[a]	0.0057[a]	0.0001[a]	0.0002[a]	9.4
3	13	7.46	0.0001	0.0017	Nil	Nil	9.4
3	11	7.46	0.0017	0.0140	Nil	0.0005	8.6
3	12	7.46	0.0011	0.0018	Nil	Nil	9.2
4	9	7.46	0.0004[a]	0.0022	Nil	0.0001	7.8
4	12	7.46	0.0000	0.0003	Nil	Nil	9.1
4	17	7.46	0.0016[a]	0.0065[a]	Nil	0.0001[a]	9.6
5	15	6.94	0.0029[a]	0.0015[a]	0.0001[a]	Nil	9.6
6	18	7.46	0.0033[a]	0.0043	Nil	0.0001	9.2
7	23	7.46	0.0108	0.0119	0.0002	0.0002	9.3
Storage tank	14	6.30	0.0072	0.0008	0.0003	Nil	9.0
Storage tank	14	6.30	0.0043	0.0004	0.0002	Nil	9.0

[a] Indicates weight gain.

John E. Reese, Hercules Powder Co., Brunswick, Ga.

LITERATURE CITED

1. Dusenbury, M. R., and Reese, John E., *Tappi* 35, No. 8: 365–367 (Aug., 1952).

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Effect of Pressure on Blocking of Wax Coatings

H. C. MOYER and R. R. DAVIS

Pressure, as well as temperature, can affect the blocking properties of wax coated paper. Extensive added damage due to pressure has been measured in some wax coatings, while other waxes show little of this effect—their blocking points being determined largely by temperature alone. These findings resulted from the use of a newly developed device which measures the effect of pressure and temperature on the blocking tendency of paper coated with various wax compositions.

BLOCKING of wax coatings can be a very real problem as many paper converters will attest. What causes blocking or sticking of wax coatings, and what means can be used to measure properly this little understood property? Lacking a fully suitable industry-wide test, many converters have developed their own blocking tests, but these are often not fully satisfactory, nor do they fulfill the need for an industry-wide standard.

However, progress has been made on this problem. The recent development of the temperature-gradient blocking test has provided an improved method for measuring the blocking point of wax coatings.* It has an advantage over older methods of affording a convenient "picture" of blocking characteristics of a wax. For example, a single test strip shows the unmarred coating, the tendency for dulling and spotting, the degree of blocking over a wide temperature range, the "blocking point" or temperature below which little or no blocking occurs, and the severity of blocking damage.

The gradient blocking test, however, does not take into consideration the effect produced by pressure on a coating. Since much of the wax coated paper is subjected to pressure at some time during its preparation, storage, or useful life, it is reasonable to include the factor of pressure in a blocking test. The work described below was undertaken to investigate the effect of pressure on wax blocking.

Basically, the gradient blocking test consists of placing two waxed strips face to face and laying them along a metal plate. A metal bar placed on top of the strips insures good contact between the waxed surfaces. The plate is heated at one end and cooled at the other so that a controlled temperature gradient exists along its length. When the strips are removed and pulled apart, the point is noted at which blocking occurs. This point corresponds to a specific temperature on the plate, and this is taken as the blocking point. The blocking point is defined as the lowest temperature at which 50% or more of the wax film is disrupted. The lowest temperature where any disruption, or picking, is found may also be noted.

In order to study the effect of pressure on wax blocking characteristics, it was necessary to develop and construct an apparatus which combined pressure as well as temperature factors. The pressure blocking plate, as developed, combines the principle of the temperature-gradient method and the ability to exert any desired pressure up to 400 p.s.i.g. on the test coating. Details of the apparatus and test procedure are given at the end of this article.

In the work described herein, crystalline petroleum waxes of fully-refined quality, modified by additives in some cases, were used as the coating materials. All coatings tested on the pressure apparatus were simultaneously tested on the regular gradient blocking apparatus in order to obtain a direct comparison of pressure-temperature effects versus the effects of temperature alone.

The findings are summarized as follows:

1. Pressure lowered wax blocking and picking points in nearly all cases.
2. Pressure lowered the blocking point of some waxes much more than others. This was true even though the blocking points might be the same by the regular gradient method.
3. The blocking point of any wax was depressed to about the same extent using 100, 250, or 400 p.s.i.g. pressure. A pressure of 50 p.s.i.g. produced less effect.
4. Extending the time of applied pressure usually produced additional lowering of blocking point.
5. Introduction of certain additives caused much greater change in the pressure blocking point than in the gradient blocking point. Low concentrations of polyethylene lowered the pressure blocking point markedly.

UNMODIFIED PARAFFIN WAX

Thirteen fully-refined crystalline petroleum waxes, representing a variety of melting point grades and methods of processing, were selected for this blocking point study. Table I lists the gradient blocking points of these waxes and also the blocking points determined under a pressure of 100 p.s.i.g.

A surprisingly large difference between the gradient blocking and pressure blocking points was found in some waxes. Other waxes showed little of this effect. No particular correlation was noted between wax physical properties and a tendency for the blocking point to be greatly reduced by pressure. Nor could the blocking differences be attributed to the coating characteristics of any particular wax. Since the results in Table I are averages of two or more tests and agreement between tests was quite good, the results are believed to represent valid differences in blocking characteristics.

The temperature at which traces of blocking, or picking, occurred was also found to be markedly lowered by pressure in some cases. As might be expected, the waxes showing the most change in blocking point from

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* The gradient blocking test has been under study by Section VI of the TAPPI-ASTM Technical Committee on Petroleum Wax. It is expected that it will soon be released as a TAPPI Suggested Method. In this test, blocking points are read to the nearest degree Fahrenheit and can be expected to correlate with results obtained using TAPPI Standard T 477 m-47, which gives results in 5° steps.

pressure also showed the most change in picking point. These results are listed in Table II.

Since pressure probably acts to magnify the effect of irregularities in a coating, it is not surprising that picking may occur over an unusually wide temperature range. It also follows that the lowest temperature at which picking may occur will be subject to considerable variation for different coatings of the same wax. The picking values in Table II, however, represent averages of several tests, and illustrate the unmistakable trend caused by pressure. An exception to this trend which the authors cannot explain is the case of the 128.2 m.p. wax.

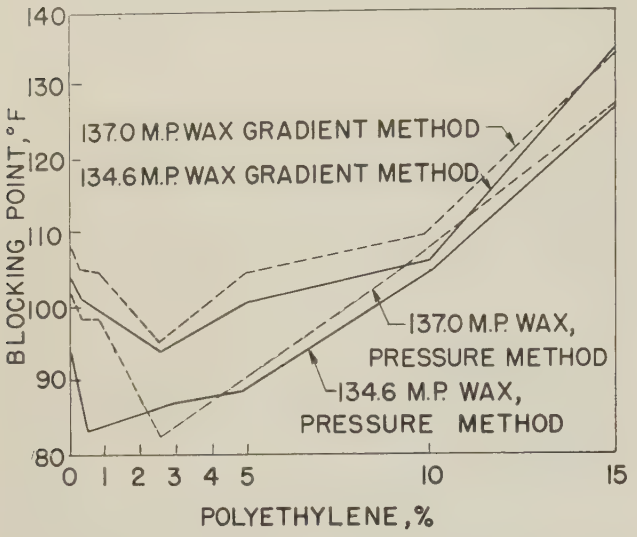

Fig. 1. Blocking points of wax-polyethylene blends by pressure method (100 p.s.i., 16 hr.) and gradient method

Although examples were found to the contrary, the use of higher pressures (specifically, 250 and 400 p.s.i.g.) did not generally produce greater blocking point depression than 100 p.s.i.g. Tests conducted at 50 p.s.i.g. showed a definite, though reduced, effect. Increasing the duration of applied pressure, however, usually produced further lowering of the blocking points, as illustrated in Table III.

ADDITIVE BLENDS

Some unusually interesting results were obtained on wax-additive coatings, emphasizing further the effect that can result from pressure. Perhaps the most interesting cases involved the use of wax-polyethylene blends. Figure 1 illustrates data from two series of such blends in which various percentages of polyethylene (mol. wt. approx. 12,000) were incorporated into paraffin waxes.

While polyethylene is usually considered to be an effective additive for raising wax blocking point, this does not appear always to be the case, particularly where less than about 5% polyethylene is used. In the cases shown in Fig. 1, wax blocking point, as measured by the gradient method, has actually been lowered by inclusion of small amounts of polyethylene.

The striking feature, however, is the additional lowering of the blocking point due to pressure. At polyethylene concentrations of about 2.5%, the pressure blocking points of the two waxes in question decrease nearly to room temperature. In contrast, at polyethylene concentrations above 10%, pressure has little effect, and blocking points increase rapidly with increasing polyethylene content.

Table I. Pressure Blocking and Gradient Blocking Temperatures of Fully-Refined Petroleum Waxes

	Gradient blocking point, °F., 16 hr.	*Pressure blocking point, °F., 16 hr. at 100 p.s.i.g.*	Δ, °F.
140/42 ASTM range			
142.2 m.p.	117	116	1
141.8 m.p.	118	108	10
141.0 m.p.	117	93	24
142.0 m.p.	109	84	25
142.8 m.p.	110	77	33
135/37 ASTM range			
136.8 m.p.	109	109	0
137.0 m.p.	108	103	5
137.3 m.p.	106	78	28
128/30 ASTM range			
128.2 m.p.	93	93	0
130.0 m.p.	94	93	1
Other ASTM waxes			
134.6 m.p.	104	95	9
149.6 m.p.	123	121	2
150.4 m.p.	129	125	4

Table II. Picking Temperature of Fully-Refined Petroleum Waxes

	Gradient Test, °F. 16 hr.	*Pressure test, °F. 16 hr. at 100 p.s.i.g.*	Δ, °F.
140/42 ASTM range			
142.2 m.p.	115	105	10
141.8 m.p.	114	101	13
141.0 m.p.	116	91	25
142.0 m.p.	109	84	25
142.8 m.p.	108	77	31
135/37 ASTM range			
136.8 m.p.	101	101	0
137.0 m.p.	106	99	7
137.3 m.p.	103	77	26
128/30 ASTM range			
128.2 m.p.	83	90	−7
130.0 m.p.	87	87	0
Other ASTM waxes			
134.6 m.p.	101	91	10
149.6 m.p.	120	118	2
150.4 m.p.	124	124	0

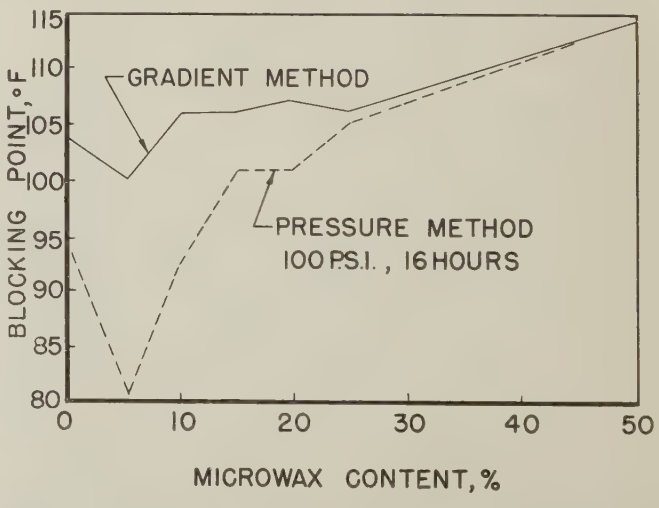

Fig. 2. Blocking points of 134.6 m.p. paraffin wax-microcrystalline wax blends by pressure and gradient methods

While the results shown in Fig. 1 involve the use of only two waxes, blends of polyethylene with other waxes have shown generally similar results. However, these observations may not apply equally to all base waxes.

Table III. Pressure Blocking Temperatures of Fully-Refined Waxes. Effect of Greater Pressure and Longer Holding Period

ASTM Wax	Pressure, p.s.i.g.	Pressure blocking point, °F. 16 hr.	64 hr.	Δ, °F.
142.2 m.p.	100	116	107	9
	250	113	104	9
137.0 m.p.	100	103	101	2
	250	103	95	8
134.6 m.p.	100	95	94	1
	250	97	89	8
130.0 m.p.	100	93	88	5
	250	80	83	−3[a]
128.2 m.p.	100	93	91	2
	250	93	91	2
149.6 m.p.	100	121	117	4
	250	120	111	9

[a] This variation apparently due to the normal spread of blocking results.

It should be mentioned here that the gradient blocking test has not as yet been evaluated or recommended by its originators as a method for testing wax blends. However, the writers see no reason why its use will not be broadened to include blended coatings in the future.

Figure 2 illustrates the effect of pressure on the blocking points of blends of crystalline and microcrystalline wax. The microwax used was derived from Mid-Continent petroleum and had a needle penetration of 45 at 110°F. It was relatively hard, tack-free, and of low bonding strength. However, in spite of its good blocking resistance, its effect as an additive was to lower the blocking point of the base wax when used at concentrations up to about 10%. Here, again, the additional effect of pressure was to lower the blocking temperature drastically. At microwax concentrations above 25% the effect of pressure became nil for blends of this series.

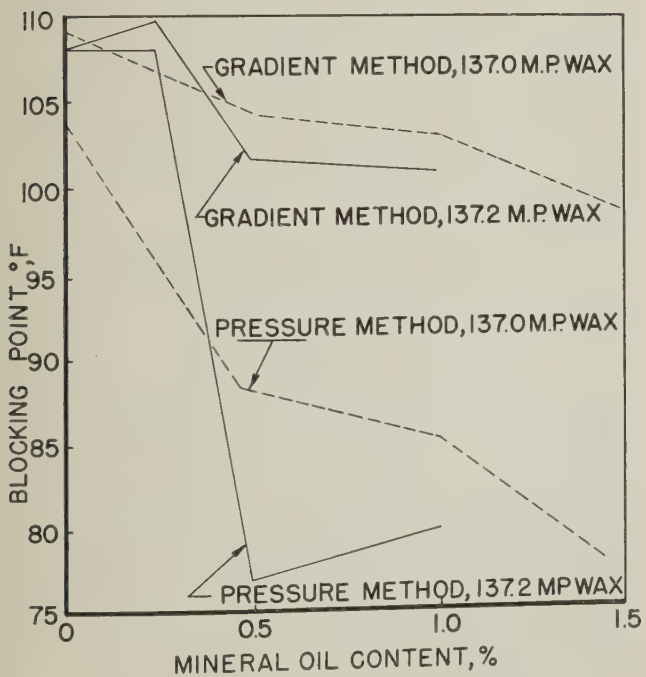

Fig. 3. Blocking points of wax-mineral oil blends by pressure method (100 p.s.i., 16 hr.) and gradient method

Figure 3 illustrates results on crystalline waxes containing various percentages of added mineral oil. The effect of pressure is very pronounced in these samples. It should not be inferred that all blends of this type will necessarily show such a marked reduction of blocking point under pressure. Nor should it be concluded that any wax with a high oil content will show this effect.

PRESSURE BLOCKING APPARATUS AND TEST PROCEDURE

The pressure blocking plate used in this work (see

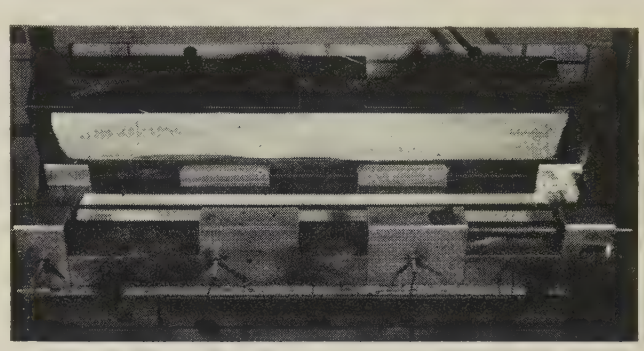

Fig. 4. Pressure blocking apparatus showing cover in open position and specimens in position for testing

Fig. 4) is basically a temperature-gradient plate of the Marathon type, fitted with a heavy metal cover. A recess in the bottom side of the cover contains a flat rubber bladder covered with a thin sheet of foam rubber which makes the recessed area flush with the surrounding metal. When the cover is closed upon the specimens to be tested and the bladder pressured with nitrogen, a uniform pressure is exerted along each specimen.

A thermostatically controlled electric heater is embedded across one end of the base. Water at constant temperature circulates through the other end. By establishing constant temperatures at the hot and cold ends, a fixed gradient is established along the entire length of the plate and this can be accurately calibrated.

The paper used for all coatings was a sulphite breadwrap stock. In order to produce specimens having very distinct blocking points, a test surface wax coating of 12 to 13 lb. per ream, chilled with 50°F. cooling water, was used for both pressure and gradient tests. All tests were made on specimens coated the previous day and aged overnight at 73°F. and 50% R.H. After conditioning, the strips coated for the pressure test were folded face to face and placed individually in cellophane envelopes to prevent cross contamination and damage to the rubber.

SUMMARY

The results of this work demonstrate that the blocking temperature of wax coated paper may be considerably lowered if the paper is subjected to sufficiently high pressure—about 100 p.s.i.g. for the waxes studied. Thus, two waxes having the same gradient blocking temperature may have widely different blocking temperatures as measured under pressure. Whether a waxed paper coating is likely to be subjected to a pressure of this magnitude has not been established. However, it seems likely that paper converters are experiencing blocking difficulty in which pressure is an important factor.

Received Feb. 9, 1955. The authors wish to extend their thankful appreciation to R. R. Edison, R. J. Buehler, and J. H. Kirk for their contributions toward the design and successful operation of the pressure blocking apparatus; to E. F. Lebryk for the blocking point measurements; and to H. E. Bryson and W. B. Watson for their welcome interest and encouragement during the course of this work.

The Drying of Paper Coating Clays

BERNARD K. ASDELL

A brief review of the drying mechanism of clay is presented. For the first time, the spray drying of clay is compared to the more conventional methods. Pertinent data on the source and possible cause of hard particle development in clays dried by conventional methods are presented. Below a certain critical moisture content, a linear relationship is found between hard particle residue and moisture of clay dried by conventional methods. It is shown that hard particles originate on the surface of drying clay bodies. It is suggested that hard particles are the combined result of surface shrinkage during drying and crystallization and cementation effect of salts. In order to keep hard particles to a safe low level, salt content must be low and clay should not be dried to less than about 5% moisture by conventional methods. Photomicrographs of spray dried clay show it is composed predominantly of small spherical beads with a partly hollow spongy interior. The mean particle size of these beads is about 175 mu. This unique physical form results in a relatively high bulk density and gives exceptionally good handling qualities by comparison to other physical forms of clay. Spray drying, for the first time, offers a means of processing clay to less than 1% moisture in a single stage without danger of developing hard particles.

THE clays used in the paper industry for coating and filling are hydrous aluminum silicates. As might be expected of a hydrous mineral, clays are relatively sensitive to drying conditions. This is particularly true of the finer fraction clays used in paper coating.

In the early days of domestic coating clay development a "hard particle" condition sometimes caused trouble in coating make-down.

Various approaches have been made to the solution of this hard particle condition, one of which was the development of high solids slurry clays for shipment in tank cars (*3*). In this process drying was eliminated, or in some instances only a small amount of dried clay was used. Great improvements in hard particle condition have been made in the clay industry over the past few years, through the use of improved drying equipment, a better understanding of the drying mechanism of clay, and improved treatment and processing methods ahead of drying. With the increasing use of high-speed, roll-type coaters in the paper industry, however, the presence of hard particles in clay has become even more critical, so that it is still a condition that must be watched and controlled in everyday operation.

It is the purpose of this paper to review briefly the mechanism of clay drying, to present pertinent information on the source of hard particles, and for the first time, to compare spray drying with the more conventional methods of drying clay with respect to development of hard particle conditions and the physical characteristics of the product.

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THE MECHANISM OF CLAY DRYING

Morgan and Hursh (*1*) made a rather complete investigation of the mechanism of clay drying. Their results showed that drying took place in two stages and that the actual rate of evaporation from clay bodies was of the order of one-half the rate of free liquid evaporation for the given drying conditions.

In the initial stage, it was found that the drying rate decreased slowly at a uniform rate as a result of the reduction of drying surface caused by shrinkage and the increased resistance to diffusion caused by the accompanying reduction in pore size. This initial period continued until the shrinkage of surface was completed at "the surface shrinkage limit." During the initial period, evaporation occurred at the surface, the surface liquid being maintained by liquid diffusion from the interior. After the surface shrinkage limit was reached, any further evaporation caused the zone of complete pore saturation to recede to the interior of the solid, so that diffusion to the surface involved vapor diffusion as well as liquid diffusion. Because of greater resistance to vapor diffusion, the drying rate fell off rapidly after the surface shrinkage limit was reached, to give the second much slower drying rate period.

No period of constant rate evaporation was found with clays as is the case with many other solids.

In a continuing study of the factors effecting the drying of clays, Sullivan and Graham (*2*) showed that the drying rate decreased from hydrogen, to calcium, to sodium clay, in conformity with the generally accepted theory of the amount and tenacity with which adsorbed water films were held by the forces of molecular and ionic attraction which surround the clay particles.

Norton (*4*) suggested that, when clay is completely dried, even these adsorbed surface films may be removed and the clay particles are then in actual contact and are held together firmly.

THE SOURCE OF HARD PARTICLES

A study was made to determine the source and cause of hard particle residues. The method used for this investigation was a standardized dispersion procedure, combined with elutriation to separate all undispersed particles coarser than 15 mu equivalent spherical diameter (see appendix). There are normally no true particles in coating clay as coarse as 15 mu when the fraction is made. Particles as fine as 15 mu in the small amounts present after drying, are not likely to cause any trouble in coating. The 15-mu separation was arbitrarily chosen as giving the degree of sensitivity necessary for carrying out the test work and comparisons.

The first work was done on a fine fraction coating clay dried on an endless traveling belt-type drier. A linear relationship was found between the moisture content and the undispersed residue coarser than 15 mu.

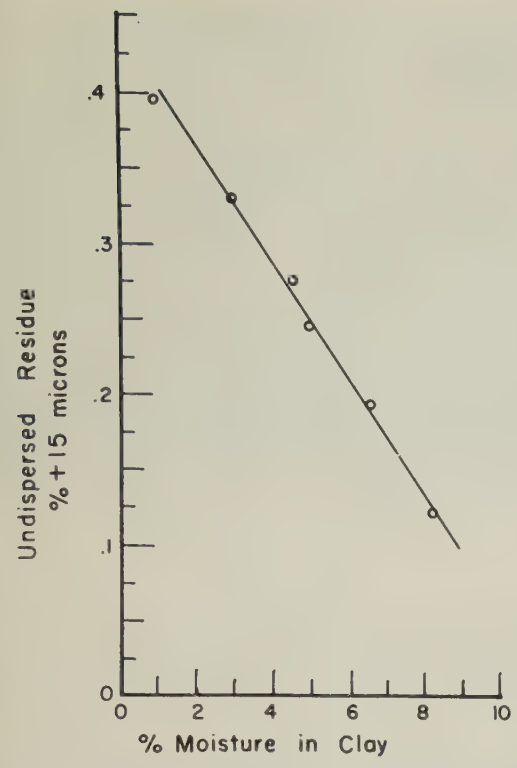

Fig. 1. Correlation of moisture in clay with undispersed residue

Figure 1 shows that as the moisture content decreased the residue increased. A projection of the line to zero residue cuts the moisture scale at about 11.5%. In view of the drying mechanism previously described, this critical moisture content at which the residue appears might be interpreted as coinciding with the beginning of pronounced surface shrinkage or surface dryness.

When investigations were made on coating clay dried in a rotary kiln-type drier no correlation was found between moisture content and residue. This was puzzling, until it was discovered that dust picked up by the cyclone collector system had a residue nearly three times as great as the combined drier discharge, as shown in Table I. It was suspected that the rolling of the charge as it progressed through the drier tended to continually grind off the surfaces of the clay bodies and that the collector system dust was made up largely from this material. If this did account for the source of the high residue in the collector material, then we should expect to find the source of the harder residue on the surface of clay bodies which were dried in an undisturbed condition.

To check this point, drier feed stock was dried undisturbed in a laboratory oven. On one portion the whole clay body cross section was tested for residue. The surface film was removed from two other portions, one by scraping, and one by means of an air blast and

Table I. Residue in Rotary Drier Clay

	Per cent + 15 mu in total product	*Moisture, %*	*Per cent + 15 mu in cyclone product*	*Moisture, %*
Average	0.135	3.6	0.35	1.0
Maximum	0.196	9.0	0.64	2.2
Minimum	0.102	0.0	0.13	0.4
Samples, no.	8		6	

Table II. Comparison Surface and Interior Residue

	Residue, % + 15 mu
Total cross section	0.262
Cross section with surface film scraped off	0.032
Cross section with surface film removed by air blast	0.024

the remaining cross sections tested for residue. The cross sections with the surface films removed had a residue of only about one tenth that of the undisturbed cross sections, as shown in Table II. This proved that the hard particle residues originated on the surface of the drying clay bodies.

Conductivity tests on the surface film scrapings from drier feed stocks showed much higher readings than on material taken from the interior. It was found, too, that washing the drier feed stock greatly reduced the conductivity readings. These results shown in Table III, suggest that soluble salt residues, which are present in small amounts in all commercial clays play an important role in the development of hard particle residues.

In continuing experiments, clay slurries were treated with variable amounts of a sequestering reagent before filtering. The filter press cakes containing about 33% moisture, were dried to zero moisture content and surface film scrapings tested for residue and conductivity. As shown in Table IV, the minimum residue at 0.3% reagent was about one eighth that of the untreated sample and the minimum conductivity was less than one half that of the untreated sample. The sequestering reagent may be considered as having two possible effects in hard particle reduction: (1) the effective removal of certain specific ions such as the alkali metal and heavy metal group, (2) prevention of salt crystallization in the drying surface films.

To summarize, it was proved that hard particles developed on the surface of drying clay bodies below a certain critical moisture content. Residual soluble salts in the clay played an important role in the development of hard particles. The data suggested that the concentration and crystallization of salts in the surface film, combined with the normal surface shrinkage

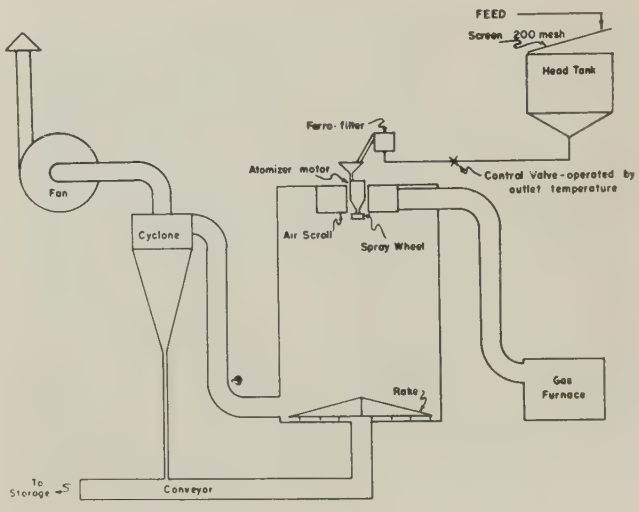

Fig. 2. Diagram of spray drier system for clay

Table III. Conductivity of Dried Filter Cake Surface and Interior

	Conductivity, reciprocal ohms × 10^6	
	Unwashed	*Washed*
Scrapings from surface	63.5	10.6
Cake interior	6.7	3.8

below the critical moisture content were the two primary factors in hard particle development. It follows, that if good removal of salts is obtained before drying and drying is stopped with an appreciable moisture content in the clay, the hard particle residue will be at a minimum.

METHODS OF DRYING CLAY

Steam Drying Racks

Filter press cakes were stacked on racks over steam coils with only gravity air circulation.

Drying time was long, moisture in product very non-uniform and localized overdrying occurred.

This method was abandoned a number of years ago because of inefficiency, high labor costs and poor product quality.

Tunnel Driers

Filter press cakes were stacked on tray cars and pushed through a hot air tunnel.

Because of thickness of cakes and method of stacking very long drying periods were required, up to 24 hr. or more. Moisture in finished product was non-uniform and very difficult to control. Local overdrying occurred.

This method, too, succumbed to inefficiency and high cost.

A review of old records showed that a large number of hard particle complaints were received from clay users while these two methods of drying were in use.

Rotary Kiln Driers

Many rotary kiln driers are used in the clay industry today. This drier is limited as to the moisture (about 25 to 30%) and consistency of the feed. With filtered coating clay some predrying such as steam drums, or

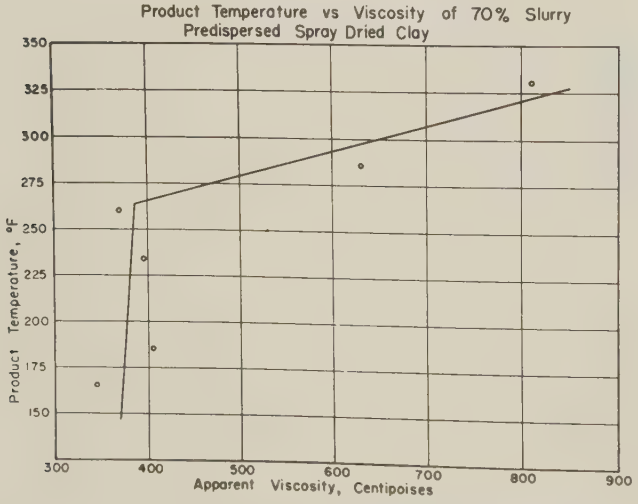

Fig. 3. Effect of product temperature viscosity of predispersed clay

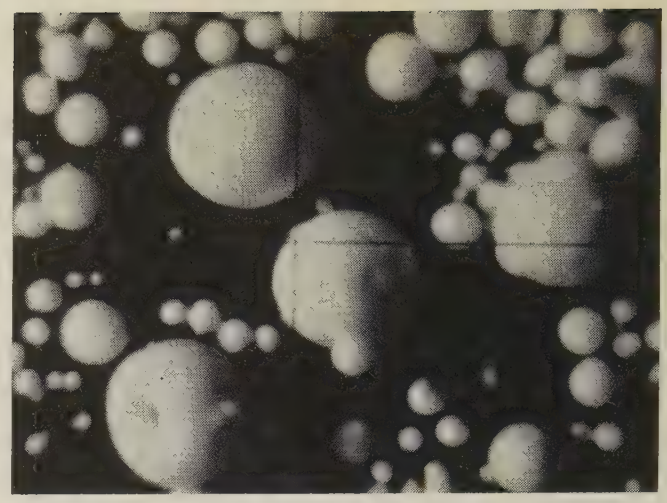

Fig. 4. Photomicrograph showing beaded form of spray dried clay. All sizes represented

recycling of a portion of the dried product is usually required to condition the feed.

If the feed cake is too wet and sticky, clay adheres to the hot metal surfaces, forming a scale which becomes overdried and finally scales off to cause hard particle contamination of the product.

With finer fraction coating clays it is not considered advisable to make a product below 5% moisture without special precautions. The rotary drier is not adaptable to predispersed clays.

Endless Belt Driers

A number of endless perforated metal belt-type driers are in use in the clay industry on coating clays.

The feed stock to these driers (about 35% maximum moisture) is extruded through a perforated plate extending across the width of the moving belt to give a material of uniform cross section and uniform bed depth. Hot air is circulated through the perforated belt and the bed of clay. The drying chamber is sectionalized along the belt length to give zones in which conditions can be independently controlled.

From the standpoint of control, these driers have considerable advantage over the rotary drier. Material is in contact with hot metal surface, however, and the fine scale from the belt which collects separately must be reprocessed in order to prevent excessive hard particle contamination.

The product moisture from these driers should not be lower than 5%, without special precautions. These driers are not adaptable to predispersed clay.

Atmospheric Twin Drum Driers

The atmospheric drum drier consists of two steam heated drums with accurately machined and polished surfaces rotating in opposite directions with adjustable

Table IV. The Effect of Sequestering Agent on Hard Surface Residue

Amount of reagent, % of clay weight	*Residue, % + 15 mu*	*Conductivity, reciprocal ohms × 10^6*
None	1.54	39.5
0.1% reagent	1.36	24.9
0.2% reagent	0.31	18.3
0.3% reagent	0.19	18.3
0.5% reagent	0.66	22.3

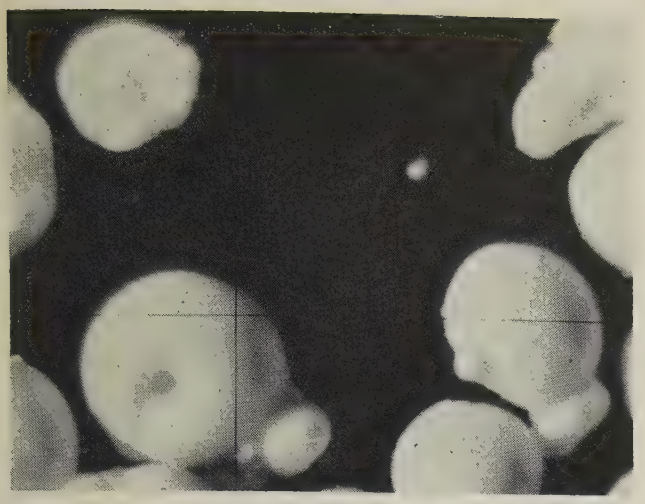

Fig. 5. Photomicrograph, largest bead size. Note fragment in upper left showing hollow interior

clearance of the nip between. Clay slurry, usually predispersed is applied by a splash feed arrangement to the bottom side of the drum. The nip between the rolls spreads the clay into a thin film which dries in passing around the drum and the dried film is removed by a scraper blade.

Drying time is very rapid on these driers, of the order of 4 to 8 sec., depending on feed solids, drum speed, steam pressure, and product moisture.

The drum drier is particularly adaptable to predispersed clays.

Optimum operating conditions are obtained with a product moisture of 3 to 5%. Lower product moisture is obtained at considerable sacrifice in production rate and the risk of hard particle formation.

Flash Drying Systems

Pulverizers, equipped with flash drying systems, should be considered as auxiliary driers to the types already mentioned. Lump or drum dried clay at a moisture content in the range of 5 to 10%, when passed through a pulverizer equipped with a flash drying system may safely be reduced to less than 1% moisture without danger of hard particle formation. This system has the disadvantage of producing a very bulky and very dusty product.

Spray Driers

With the exception of the twin drum drier, all those described above must operate on clay bodies of considerable thickness, of the order of 1/4 to 1 in. The drying time is of necessity prolonged because of the limited drying surface exposure. The drying time in rotary driers, for example, may be of the order of 30 min. or more.

The spray drier differs radically in principle from all of the others commonly used on clay. The feed in the form of a pumpable slurry is atomized into a current of hot air in a cylindrical drying chamber. Because of the enormous surface development per unit weight, the clay dries very rapidly while suspended in air out of all contact with hot metal surfaces.

Figure 2 is a diagram of a typical co-current spray drier installation for clay.

The feed slurry, after passing through a fine mesh screen (200 mesh) and liquid electromagnet for final scalping, passes into a centrifugal atomizing wheel operating at 9200 r.p.m. Hot air at 800 to 820°F. enters around the spray wheel at high velocity. The slurry is atomized as fine droplets into the hot air stream where it dries very rapidly. The chamber volume to air flow volume is such that a complete change of air occurs about every 30 sec. Since the drying rate is in balanced equilibrium, we may assume that the average drying time is also about 30 sec. The dried spherical droplets fall to the chamber floor where they are quickly discharged. The air, carrying water vapor and some dust (10 to 15% of output), is discharged from the drying chamber through a set of cyclone collectors by an exhaust fan. The dust from the collectors may be discharged into a common conveyor where it is mixed back with the drying chamber discharge, handled as a separate product, or recycled to the feed slurry.

Seltzer and Settlemeyer (*6*) have shown that the temperature gradient in co-current spray driers is very steep, the greatest drop occurring within a radius of a few feet of the spray head. Because of the very rapid drying rate and accompanying rapid temperature drop, the driest product is always in contact with the coolest air, so that there is little chance of overheating the product. The product temperature in co-current spray driers is always considerably lower than the outlet air temperature. With normal outlet air temperatures of 220 to 230°F., the product temperature runs in the range of 160 to 180°F. The outlet air temperature is preset in a control instrument which automatically adjusts the feed to give constant temperature drop through the drier.

The spray drier is particularly adaptable to predispersed clays. Predispersed clays are relatively sensitive to high temperatures, or to lower temperatures for longer periods of time. For example, if predispersed slurry at, say 70% solids, is dried at near the boiling point in an oven and the dried material put back into suspension at the same solids, the viscosity may be many times greater than the original slurry. It has been shown in spray drier operation that no adverse effects result on viscosity until product temperatures of about 260°F., are reached, which is far above normal product temperatures. Data correlating product temperature and viscosity are shown in Fig. 3.

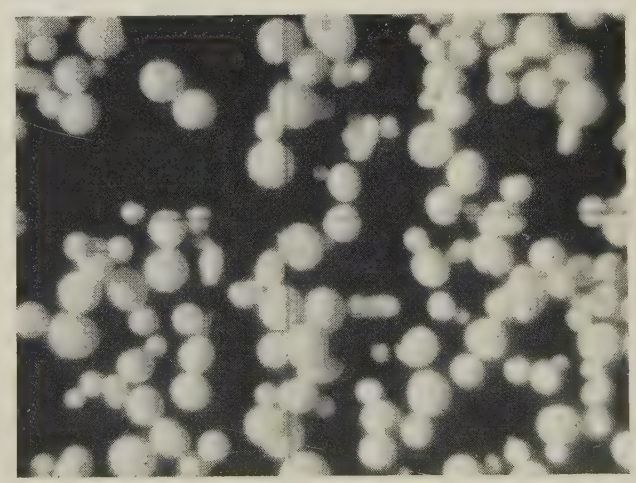

Fig. 6. Photomicrograph, spray dried clay finer than 200 mesh

Table V. Per Cent + 15 mu Residue in Clay from Different Types of Driers

	Av.	Max.	Min.	No. tests	Increase over feed stock
Spray drier[a]	0.078	0.124	0.050	14	0.011
Rotary drier	0.135	0.196	0.102	8	0.082
Belt-type drier	0.280	0.488	0.130	10	0.258
Drum drier[a]	0.237	0.412	0.054	8	...

[a] Predispersed clays.

Compared to the other methods described spray drying develops the least hard particles, as shown in Table V. The superiority of spray drying in this respect, might be attributed to the very short drying time and the very large surface area development due to fine atomization. The short time tending to minimize salt crystallization and cementation effects, while the large surface area tends to dilute the surface concentration of salts. Since the drying rate is rapid enough to be very nearly explosive, it seems likely also, that surface shrinkage effects are greatly minimized as compared to slower drying methods. Furthermore, in spray drying the clay is not in contact with hot metal surfaces while in a sticky plastic condition, but is dried while suspended in mid-air. It has already been pointed out that clay scale formation on the hot metal walls of other type driers may be a source of hard particle contamination in addition to that developed on the clay body surfaces.

To summarize the drying methods compared, spray drying showed the least development of hard particles. Minimum product moisture of 4 to 5% was indicated by other drying methods to prevent excessive development of hard particles, while the spray dried product was less than 1% moisture. In order to obtain less than 1% moisture by methods other than spray drying, auxiliary pulverizing combined with a flash drying system was indicated.

The fact that spray drying did not adversely affect the viscosity of predispersed clay indicated that the drying conditions, while very rapid, were also essentially very mild.

Because the feed to the spray drier was a pumpable liquid, scalping by means of fine screening and an electromagnet was possible less than 1 min. ahead of complete drying. This made possible a product exceptionally free of extraneous contamination.

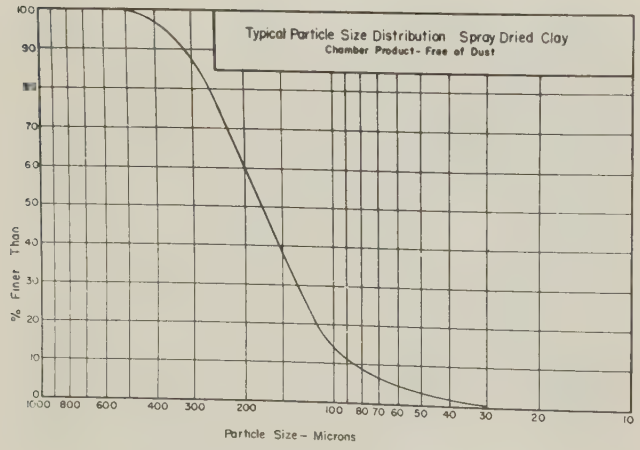

Fig. 7. Typical particle size distribution of spray dried clay beads

THE ADVANTAGES OF SPRAY DRIED CLAY

Spray dried coating clay offers several advantages over those dried by other methods. It produces a unique physical form not obtainable by other methods. When the discharge product from the bottom of the drying

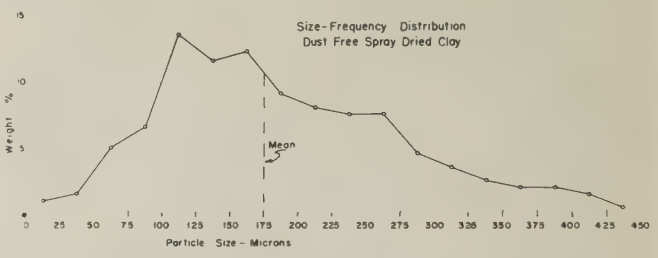
Size-Frequency Distribution
Dust Free Spray Dried Clay
Weight %
Mean
0 25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450
Particle Size - Microns

Fig. 8. Size-frequency distribution of spray dried clay beads

chamber is placed under a microscope it is found to be composed entirely of small spheres of various sizes as shown in Fig. 4. Some of the spheres show a distinct surface dimple. The dimpled spheres, if broken open are found to be partly hollow inside. In the upper left center of Fig. 5, is a broken fragment revealing the partly hollow, spongy appearing interior of one of the larger spheres.

The dimpled surface characteristic persists even in the smaller diameter spheres, as shown in Fig. 6, in which all particles are finer than 200 mesh (74 mu). In this picture, also, are some elongated particles believed to be filaments which dried before forming into spheres.

The partly hollow interior of the spray dried clay spheres and dimpled surface are believed to be the result of rapid vapor expansion, causing a "blow out" while the particle is still in a plastic state. The dimple seems to be the result of the collapse of material around the blow out crater.

A typical particle size distribution (determined on a set of U. S. Standard sieves) of the clean, dust-free spheres from the drying chamber discharge is shown in Fig. 7. The mean particle size on a weight basis is about 175 mu (approx. no. 80, U. S. Standard sieve). About 99% is finer than 420 mu (no. 40, U. S. Standard sieve) and about 3% finer than 44 mu (no. 325, U. S. Standard sieve).

The size-frequency distribution on a weight basis is presented in Fig. 8. It shows that sizes between 100 and 200 mu occur most frequently.

It was pointed out above that the dust picked up in the cyclone collector system may be mixed back into the main product discharged from the drying chamber. If this is done the dust tends to agglomerate on the surface of the clean spheres from the drying chamber so that all the surface feature details are obscured and they have the appearance of fuzzy "cotton balls," as shown in the photomicrograph of Fig. 9. The dust adheres to the surface of the spheres with considerable force.

The predominantly small, spherical bead form of spray dried clay makes it a relatively dense product, typically more than 50 lb. per cu. ft. at the drier discharge. It is the densest form of coating clay containing less than 1% moisture. Its density is generally somewhat higher than drum dried clay and is exceeded

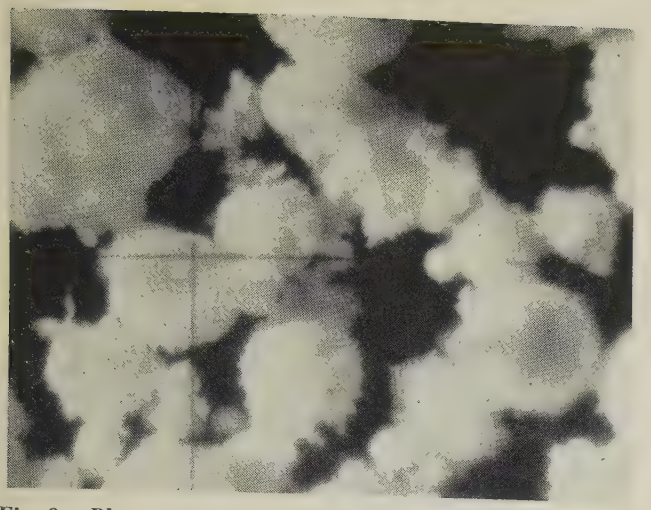

Fig. 9. Photomicrograph of spray dried clay beads showing dust adhering to surface

only by lump clay and high solids slurries (68 to 70% solids), both of which have higher moisture. Comparative typical bulk densities of various physical forms of coating clay at the loading point are shown in Table VI.

Because of its predominantly spherical structure and low moisture content spray dried clay flows easily in the dry state. Although, like other forms of clay it may pack considerably in cars or in storage bins it does not form a hard cake and therefore shows little tendency to "bridge" as do other physical forms. It is easily fluidized which makes it particularly adaptable to handling in pneumatic conveyor systems. It handles well, also, in screw conveyors (both horizontal and vertical), belt conveyors and bucket elevators.

Because of the ease with which it flows, spray dried clay is more easily and quickly unloaded from hopper cars than any other physical form, resulting in considerable saving in unloading costs where these cars can be used. Certain users of coating clay find it economical to receive shipments of predispersed spray dried clay in hopper cars, from which it is unloaded directly to a high density slurring system (*5*). The resulting slurry at 68 to 71% solids is stored in large tanks from which it is distributed in pipe lines to points of use. Such a system gives the economy of dry clay freight rates along with the advantages of liquid clay storage and distribution.

Some types of coating make-down equipment require clay in a fine physical form. It has been found in most such cases, that spray dried clay is fine enough to substitute for pulverized clay.

The first spray drier in the Georgia clay district was put into operation at Edgar Brothers Co. in the early part of 1942 on a coarse fraction filler clay. It was soon recognized that this method of drying and the product offered certain unique advantages. After several years of research and development work this unit was converted to one grade of predispersed coating clay. The spray drying of predispersed coating clay is the subject of U. S. pat. 2,540,182, issued to C. G. Albert (*7*).

Because of high demand and limited capacity, only one grade of predispersed spray dried coating clay has been available. With the expanded spray drying facilities expected in the near future two coating clay particle size fractions will be available.

To summarize, spray drying is more than just another method of drying coating clay. It is a new process which offers for the first time a method of processing clay to a moisture content of less than 1% in a single stage without the risk of developing hard particles. The fine spherical bead form of spray dried clay, from which its outstanding ease of handling is derived, is unique. It is fine enough to substitute in many cases for pulverized clay with the added advantage that its bulk density is nearly twice as great. Because of the bead form, spray dried clay flows easily and shows little tendency to bridge in silos and storage bins as to other physical forms of clay.

Table VI. Typical Bulk Density Range of Various Physical Forms of Coating Clay

Physical form	*Weight in lb. per cu ft.*[a]	*Cubic feet per ton*	*Average moisture, %*
Lump	57–67	30–35	5.0
Pulverized	23–27	74–87	0.5–1.5
Spray dried	48–58	34–42	0.5
Predispersed 70% slurry	109[b]	26.1	30.0

[a] On average moisture basis.
[b] 76.6 dry clay basis.

APPENDIX—UNDISPERSED + 15 MU RESIDUE TEST FOR COATING CLAYS

1. Dissolve 0.50 gram of tetra sodium pyrophosphate in about 300 ml. of water placed in a 1-pt. Mason jar provided with lid. Weigh out 50 grams of clay, add to this solution and place in a standard paint shaker for 5 min.
2. Transfer suspension to a 1000-ml. glass stoppered, graduated cylinder (32 to 33 cm. depth) and dilute to top mark. Allow the suspension to stand 40 min., then decant carefully with a syphon down to the 100 ml. mark.
3. Refill with water to the top mark, add a pinch of TSPP, and invert several times to mix.
4. Allow to stand 27 min., then decant carefully as before.
5. Repeat three and four more times, or until the water at end of settling period is clear.
6. Wash sediment into tared filter paper in Büchner funnel, filter, dry, and weigh.
7. Report sediment weight as per cent undispersed residue + 15 mu.

LITERATURE CITED

1. Morgan, W. R., and Hursh, R. K., *J. Am. Ceram. Soc.* 22: 271–278 (1939).
2. Sullivan, J. D., and Graham, R. P., *J. Am. Ceram. Soc.* 23: 57–61 (1940).
3. Dickerman, Gilbert K., U. S. pat. 2,440,601 (April 27, 1948). Assigned to Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.
4. Norton, F. H., *J. Am. Ceram. Soc.* 16: 86–92 (1933).
5. Heslop, E. G., and Hughes, H. M., *Tappi* 36, No. 2: 152–156A (1953).
6. Seltzer, E., and Settlemeyer, J. T., Spray Drying of Foods, from "Advances in Food Research," Vol. II, pp. 510–511 (1949), Academic Press, Inc., New York, N. Y.
7. Albert, C. G., U. S. pat. 2,540,182 (Feb. 6, 1951). Assigned to Edgar Brothers Co., Metuchen, N. J.

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The Sorption of Water-Soluble Cellulose Ethers by Cellulose

ELLSWORTH H. SHRIVER

A study of the effect of (1) time, (2) beating, (3) molecular weight in the 24,000 to 126,000 range, (4) rosin and alum, (5) concentration and temperature reversibility, and (6) temperature in the range 3 to 38°C. at concentrations varying from 0.005 to 0.09 gram per 100 ml. on the retention of water-soluble cellulose ethers by (a) cotton linters, (b) bleached and unbleached sulphite, and (c) bleached and unbleached kraft pulps is reported. Water-soluble methylcellulose was primarily used for the study except for limited experiments with a water-soluble ethylcellulose. Sorption required 100 to 180 hr. for completion, and was found to increase three to four times from unbeaten to well-beaten pulps. Sorptions varying from 0.1 to 7 grams per 100 grams pulp were obtained. Bleached sulphite has the greatest sorptivity followed closely by bleached kraft and unbleached sulphite, which were approximately equal. Cotton linters and unbleached kraft showed the poorest sorptivity. No effect of molecular weight in the range studied or of rosin and alum in ordinary amounts was found on sorption. Sorption was found to be irreversible with respect to isothermal concentration changes and to exhibit a temperature hysteresis. Sorption was found to increase with increasing temperature and a combination of gelation and true adsorption was postulated for the retention mechanism. The heat of retention was determined to be 21,500 cal. per mole (endothermic), the heat of gelation 29,700 cal. per mole (endothermic), and the heat of adsorption, 8200 cal. per mole (exothermic). A theory of sorption is presented.

In order to be effective in modifying paper properties, wet-end additives must be retained by some sort of sorption mechanism. Fundamental studies on additive retention by pulps have not been extensive and this is particularly true of water-soluble polysaccharides. In the study reported here, a possible sorption mechanism for the water-soluble cellulose ethers is outlined.

In a previous paper by Shriver, Webb, and Swanson (*1*) two new analytical methods for the measurement of the retention of polysaccharide beater additives by papermaking pulps were presented. One of these methods made use of the anthrone test for carbohydrates (which is more sensitive than iodine is for starch) combined with a Celite filtration technique. The other method employed the relationship between viscosity and concentration for many high polymers where the molecular distribution may be assumed constant. It was shown that these methods correlate very well but that slightly higher equilibrium concentrations are obtained on samples measured by the anthrone technique as compared with the viscometric technique. These small differences, however, result in calculated sorptions for the viscosity method which are about one and a half to two times those obtained with anthrone. This result was probably due to lack of quantitative filtration of cellulose fines in the presence of the methylcellulose which is a known deflocculating agent. The analytical variability was ascribed to the nonuniformity of pulp samples.

In the present paper, results obtained by these analytical methods in a study of the sorption of water-soluble cellulose ethers by a variety of papermaking pulps are presented.

HISTORICAL REVIEW

Water-soluble cellulose ethers are made commercially by steeping purified wood or cotton cellulose in 50% sodium hydroxide and treating with methyl or ethyl chloride under pressure at elevated temperatures. The properties of the product depend on (1) the nature of the etherifying radical and the degree of substitution (D.S.), (2) the degree of polymerization (D.P.), and (3) the uniformity of etherification as noted by Haskins (*2*). Wakeman (*3*) states that cellulose ethers are insoluble in hot water and precipitate from solution on heating. The effect of salts on methylcellulose solubility in water follows the lyotropic series; the most highly hydrated anions are most effective in decreasing the solubility. Young and Kin (*4*), and Worden (*5*) report that polybasic acids, phenols, tannins, aldehydes, and certain albumen precipitants will precipitate methylcellulose from solution. Tice (*6*) found that methylcellulose has no zeta-potential in solution.

Signer and Liechti (*7*) fractionated methylcellulose from water solution using a salting-out technique. Signer and Tavel (*8*) investigated these fractions by ultracentrifuge sedimentation equilibrium. The diameter of methylcellulose molecules was found to be 7 to 9 A, and the length D.P. times 5.15 A, indicating a long, threadlike molecule of one methylated cellulose chain.

Edge (*9*), Musser (*10*), Collins (*11*), Topping (*12*), and the Dow Chemical Co. (*13*), have referred to the use of water-soluble methylcellulose as an additive and have reported improvement in strength properties of treated pulps. A general review of beater additives has been given by Jayne, *et al.*, (*14*) which includes the utilization of methylcellulose. Erspamer (*15*) and Broadbent and Harrison (*16*) have reported that methylcellulose is a pulp deflocculator and dispersing agent. Dixson (*17*) reported that methylcellulose was particularly effective in imparting a more hydrophilic character to pulps.

Because the retention of beater additives must involve some type of sorption by the pulp, investigations on the adhesion of high polymers to cellulose are of interest. Mark (*18*) reviewed adhesion to cellulose and postulated four types of bonds: (1) mechanical bonds with 100 to 200 A bond distance, (2) polar bonds between polar groups with 4 to 5 A bond distance and a bond energy of 2 to 4 kilocalories per mole, (3) hydrogen bonds between fluorine, oxygen, or nitrogen atoms with 2.5 to 2.8 A bond distance and 5 to 8 kilocalories per mole, (4) covalent (chemical) bonds with a bond

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distance of 1.5 to 2.0 A and a bond energy of 50 kilocalories per mole or more.

Of theoretical interest in the present study is the work of McLaren (*19*), Hofrichter and McLaren (*20*), and McLaren and Seiler (*21*), who studied polymer adhesion to cellophane from hot melts. These workers found that the adhesion of a vinyl chloride-vinyl acetate copolymer increased with increasing concentration of carboxyl groups present as maleic acid according to a Freundlich adsorption isotherm. Adhesion increased with increasing temperature and the heat of adhesion was determined to be 12,500 cal. per mole (endothermic). Since adsorption normally decreases with increasing temperature, this phenomenon was explained by suggesting that adhesion is the result of an exothermic sorption process and an endothermic fluidity or cohesion process. The heat of adhesion is the sum of the heats associated with these processes and is endothermic or exothermic according to the relative magnitude of the two heats. The heat of fluidity or cohesion was experimentally determined to be 30,000 cal. per mole (endothermic) and the heat of sorption calculated as 17,500 cal. per mole (exothermic). It was also found that above a certain minimum, molecular weight did not influence adhesion of polymers to cellophane or aluminum foil

Data on the sorption of essentially neutral, highly hydrated, straight-chain carbohydrates by cellulose from water solution are not plentiful. Samec (*22*), and Pacsu and Mullen (*23*), among others, have found that the amylose (straight-chain) fraction of starch is quantitatively adsorbed by cotton or filter paper. This phenomenon may be used to separate the amylose from the amylopectin (branched-chain) fraction of starch. Amylose will desorb from cotton in the presence of hot water, indicating an irreversible sorption in cold water.

Obermanns (*24*) added wood hemicellulose material in the form of beta-cellulose to sulphite and alpha pulps and retentions calculated from Obermanns' data varied from slight to 3% for additions up to 18% on the pulp. March (*25*) added alkali-extracted hemicelluloses from aspen chlorite holocellulose to various extracted residues and retentions calculated from his data varied from 0.2 to 7% on the residue. In this work, beta-cellulose and xylan contents were determined on laboratory handsheets and consequently it may be concluded that retention was at least largely irreversible since the great dilution in the handsheet mold did not result in complete removal of the additive from the pulp.

Data on the retention of methylcellulose obtained by the Dow Chemical Co. (*26*) by analysis of the methoxyl content of dried handsheets are of immediate interest to the present study. These data show increasing retention with increasing concentration of methylcellulose in the beater liquid and with increased beating. No conclusive effect of molecular weight was demonstrated and rosin size had no effect on retention. By heating the methylcellulose above the gel point, greater retentions could be obtained, possibly due to the adherence of precipitated discrete particles of methylcellulose to the fibers. As previously noted for other straight-chain carbohydrate sorptions by cellulose, an irreversible retention for methylcellulose is probable, because handsheet analyses were made on handsheets which were made under conditions of extreme dilution compared to the conditions of the original sorption.

The reader is referred to the book by Mantell (*27*) for the theory of adsorption.

RAW MATERIALS

Table I contains analytical information on the cellulose ethers investigated in the present study.

The water-soluble cellulose ethers were obtained in five different grades and were white, fibrous products made by the Dow Chemical Co., of Midland, Mich., which kindly furnished some of the analytical data. The grade of methylcellulose or ethylcellulose refers to the viscosity in centipoises of a 2% solution at 20°C. Solutions of methylcellulose were made by soaking the material for 0.5 hr. in half the required water for dilution at near the boiling temperature. After this soak, water was added to slightly below the mark on the volumetric flask. The suspension was cooled below 10°C. until the methylcellulose was completely in solution; the solution was diluted to the mark after bringing the flask and contents to room temperature. Solutions of required concentration were made by volumetric dilution from 0.5% stock solutions. Stock solutions were stored at room temperature.

The ethylcellulose was an experimental sample and solutions were made in a manner similar to that used for the methylcellulose except that stock solutions were filtered before using, since the ethylcellulose was only 68.5% water soluble.

The pulps used for the sorption experiments consisted of (1) cotton linters from the Hercules Powder Co., (2) western hemlock bleached sulphite from the Pulp Div., Weyerhaeuser Timber Co., (3) western hemlock

Table I. Properties of Additive Raw Materials

Grade (viscosity 2% solution, 20°C.), cp.	*Alkoxyl, %*	*Ash (NaCl + Na_2CO_3), %*	*Arrhenius viscosity constant*[a] K	*Intrinsic viscosity, (η)*[b]	*Viscosity molecular weight*[c]	*Monomer weight*	*Degree of polymerization*	*Degree of substitution*
Methylcellulose (Dow Methocel)								
25	32.6	0.09	0.84	1.85	31,000	190	160	2.00
100	30.7	0.15	1.38	3.20	53,000	188	280	1.86
400	31.5	0.07	2.12	5.05	84.000	189	445	1.92
4000	30.8	0.03	3.34	7.55	126,000	188	670	1.87
Ethylcellulose								
74	33.7	0.09	0.55	1.30	24,000	205	117	1.53

[a] In Arrhenius viscosity equation $\log \eta_r = kc$ where η_r = relative viscosity, c = concentration grams per 100 ml.

[b] Defined by Kraemer as $(\eta_{sp}/c)\ c \rightarrow 0$ where η_{sp} = specific viscosity = $\eta - \eta_0/\eta_0$ (η = solution viscosity and η_0 = solvent viscosity) and c = concentration grams per 100 ml.

[c] From Staudinger equation $(\eta) = KM$, where M = molecular weight and K = Staudinger constant; 6.0×10^{-5} for methylcellulose where concentration is expressed in grams per 100 ml.

unbleached sulphite from Puget Sound Pulp & Timber Co., (4) jack pine bleached kraft from Nekoosa Edwards Paper Co., and (5) jack pine unbleached kraft from the same source.

The above pulps were beaten in a Valley laboratory beater according to TAPPI Standard T 200 m-45, except that 2000 to 4000-ml. samples were taken at the beaten intervals selected instead of the usual 800-ml. sample. Bed plate loads were 5500 grams for cotton linters and sulphite pulps and 6500 grams for the kraft pulps. All pulps were extracted with distilled water until the extracts had a pH between 6.0 and 7.0. The unbleached kraft pulp was washed with 0.01 N H_2SO_4 before extraction.

Extracted and filtered pulp pads were pulled into small pieces, thoroughly mixed, and stored in tightly capped, wide-mouth bottles at a temperature below 10°C. Consistencies varied between 16 and 30% and did not change appreciably over many months.

EXPERIMENTAL PROCEDURES

Analytical Techniques

A detailed discussion of the anthrone and viscosity analytical investigations have been given previously in the paper by Shriver *et al.* (*1*), and only a summary of the procedures will be given here. The anthrone technique was as follows:

1. The reagent consisted of 2 grams of anthrone dissolved in 1830 grams of Du Pont concentrated sulphuric acid. The acid was shaken vigorously to insure dissolution of the anthrone. The reagent was stored at room temperature and was aged 1 day before use.

2. Five milliliters of the cellulose ether solution to be analyzed (having a concentration in the range 0.001 to 0.005 gram per 100 ml.) were placed in a 25 by 150-mm. test tube and 10 ml. of anthrone reagent were cautiously added to form a double layer. The contents of the test tube were poured rapidly into a clean test tube and then returned to the original tube.

3. The test tube was stoppered and the mixture was allowed to air cool in a test tube rack for 10 min. The transmittance of the solution was then obtained using a 1-cm. absorption cell and a model 14 Coleman Universal spectrophotometer at a wavelength of 625 mmu, using reagent and water as a reference liquid. Air trapped in mixing occasionally deposited on the face of the absorption cells, and was removed by evacuation in a desiccator for several minutes.

4. For calibration, two samples of cellulose ether (0.005 gram per 100 ml.) were run and a straight line drawn through the 100% transmittance-O concentration point and the average of the two samples on a log transmittance versus concentration plot. Beer's law was obeyed at the wavelength used for analysis, and the equation for absorption was $T = 10^{-bcx}$, where T = transmittance, b = specific extinction coefficient, c = concentration in grams per 100 ml., and x = cell depth in centimeters. The specific extinction coefficient for the methylcellulose used in this study was 131, and for the ethylcellulose, 101. Calibrations were run within 1 day of the samples in order to avoid inaccuracies due to aging of the anthrone reagent. Concentrations of the sorption samples were obtained from the calibration curves.

5. The sorption of cellulose ether was calculated by subtracting the equilibrium concentration times the liquid volume of the system from the initial cellulose ether present.

The viscometric analytical technique was as follows:

1. Ten milliliters of the cellulose ether solution to be analyzed were introduced into a Cannon-Fenske (*28*), Ostwald type, series 50 capillary viscometer through a Corning coarse microfilter funnel. Liquid held in the microfilter stem was forced out with gentle air pressure. The viscometer was clamped in a bath at 25 ± 0.01°C. for 5 min. to permit temperature equilibration. The solution efflux time was measured in duplicate with a stop watch to the nearest 0.1 sec.

2. The relative viscosity of the solution was computed by dividing the solution efflux time by the solvent efflux time. The concentration of the solution was obtained by substituting into the Arrhenius viscosity equation (log relative viscosity = constant × concentration) using a constant obtained from calibration with solutions of known concentration. The Arrhenius viscosity constants used in the present study are given in Table I.

3. Allowance was made for the slight "residual" viscosity of the water extract from sulphite and kraft pulps which was apparently due to water-soluble polysaccharides leaching out of the pulp. The equation used for this correction was as follows:

$$\log \eta_{rmc} = \log \eta_{rm} - \log \eta_{rp}$$

where

η_{rmc} = relative viscosity of methylcellulose
η_{rm} = viscosity as determined
η_{rp} = relative residual viscosity of pulp

4. Sorption was calculated by subtracting the equilibrium concentration times the liquid volume of the system from the initial cellulose ether present.

Sorption Methods

All sorptions were made in 8-oz. narrow-mouth screw-cap bottles, 200-ml. Pyrex centrifuge jars, or small stock jars of 400 to 500 ml. capacity. Two hundred milliliters of a given concentration of methylcellulose (in the range 0.005 to 0.10 gram per 100 ml.) were pipetted into a bottle or jar and brought to bath temperature. Pulp (in most cases 1 gram, oven-dry) at 16 to 30% consistency was weighed to the nearest milligram and introduced into the bottle or jar and then dispersed by rapid mechanical stirring for several minutes. The container was closed tightly and rotated end-over-end at constant temperature for a minimum of 9 days (except for rate of sorption studies) to insure equilibration. The bath at 25°C. was controlled within ±0.2°C., the bath at 3.3°C. within ±0.3°C., and the bath at 38.0°C. within ±0.5°C. At the end of the rotation period, the samples were allowed to settle overnight before sampling the supernatant liquor.

A number of sampling methods were used in the present study. A combination of centrifugation and filtration operations was employed to separate cellulose ether solution from suspended fibrous material. For the anthrone analysis, the most satisfactory procedure was to remove 25 ml. of supernatant liquor from the sorption container with a pipet and centrifuge 15 min. in a field of approximately 1.5 × 10^6 cm. per sec.^{2}

centripetal acceleration with 0.1 gram of glass wool to prevent redispersion of material centrifuged out. Five milliliters of the centrifugate were diluted volumetrically so that the diluted concentration of cellulose ether was in the range 0.001 and 0.005 gram per 100 ml. Saturated filter pads were prepared by stirring 0.5 gram of Celite in 50 ml. of cellulose ether of 0.010 gram per 100

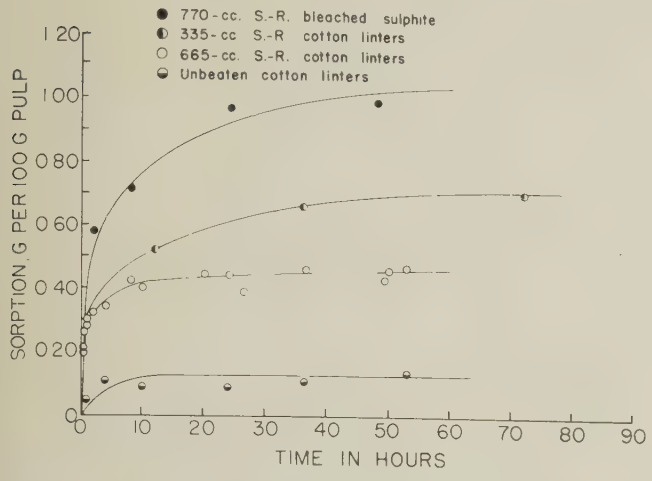
770-cc. S.-R. bleached sulphite
335-cc S.-R cotton linters
665-cc. S.-R. cotton linters
Unbeaten cotton linters
SORPTION, G PER 100 G PULP
TIME IN HOURS

Fig. 1. Rate of sorption of 400-cp. methylcellulose by cotton linters and bleached sulphite pulps at 25°C.

ml. Approximately 6 ml. of this slurry formed a 3 to 4-mm. filter pad on a Corning coarse tube-type microfilter. The Celite was treated with cellulose ether solution in order to prevent adsorption from the sorption sample being filtered. Ten to twelve milliliters of the diluted sample were sucked through the saturated Celite filter pad and discarded. An additional 6 to 9 ml. of the filtrate were then obtained in a clean 15-mm. sidearm test tube. This filtrate was again centrifuged in a clinical centrifuge for 1 min. to remove Celite dislodged from the bottom of the filter pad. The filtrate was then analyzed by the anthrone technique.

In the rate of sorption studies with cotton linters, the supernatant liquor was filtered using coarse fritted glass filter sticks without a filter aid such as Celite, and finally centrifuged before dilution and analysis. Also employed was filtration with a fine fritted glass filter stick, without centrifuging. In most of the studies made, the Celite procedure given above was used.

For analysis by the viscosity technique, the most satisfactory procedure was to decant 25 ml. of supernatant liquor from sorption samples by pipet and centrifuge 15 min. in a field of approximately 1.5×10^6 cm. per sec.^{2} centripetal acceleration with 0.1-gram glass wool to prevent disturbance of centrifuged particles. The centrifugate was then analyzed by the viscometric technique. Some analyses were made directly on the supernatant liquor without centrifuging.

EFFECT OF TIME ON SORPTION

The time required to attain sorption equilibrium is important because analytical results will be dependent on time unless equilibrium is assured. Experiments were run at 25°C. using unbeaten, 665-ml. S.-R. freeness, and 335-ml. S.-R. freeness cotton linters, and 770-ml. S.-R. freeness bleached sulphite pulp, in a 0.005 gram per 100 ml. solution of 400-cp. grade methylcellulose. Twenty-five-milliliter samples were removed at intervals and analyzed with anthrone. In calculating sorption, allowance was made for methylcellulose previously removed in analytical samples.

Results are given in Fig. 1. It was found that the curves of time versus sorption showed high initial rates (slope of curve) and then a gradually decreasing rate which approached zero (i.e., constant sorption) at 70 hr. for the 770-ml. S.-R. bleached sulphite, at 50 hr. for the 335-ml. S.-R. cotton linters, and in about 10 hr. for the 665-ml. S.-R. and the unbeaten cotton linters.

Further experiments with cotton linter pulps beaten to 795 and 635-ml. S.-R. freeness in initial methylcellulose concentrations varying from 0.0050 to 0.0250-gram per 100 ml. were made. Analyses at various times up to 288 hr. showed that for initial concentrations of 0.0150 gram per 100 ml. and above, sorption is complete in 100 hr. For lower concentrations, at least 180 hr. are required. A minimum time of 220 hr. or approximately 9 days was adopted for all future runs to insure sorption equilibrium.

From Fig. 1 it may be seen that sorption rate at a given time increases with the degree of beating, a result reflecting the known increase of pulp specific surface with beating. Sorption rate was also found to be a function of initial methylcellulose concentration. In the case of 770-ml. S.-R. freeness bleached sulphite pulp, 59% of the total sorption occurred in 2 hr. for 0.0150 gram per 100 ml. initial concentration, and 83% of the total sorption in 2 hr. for 0.0500 gram per 100 ml. initial concentration.

A log time versus log sorption plot of rate data gave a series of straight lines. The relationship is of the form $x/m = at^n$, where x/m is grams sorption per 100 grams

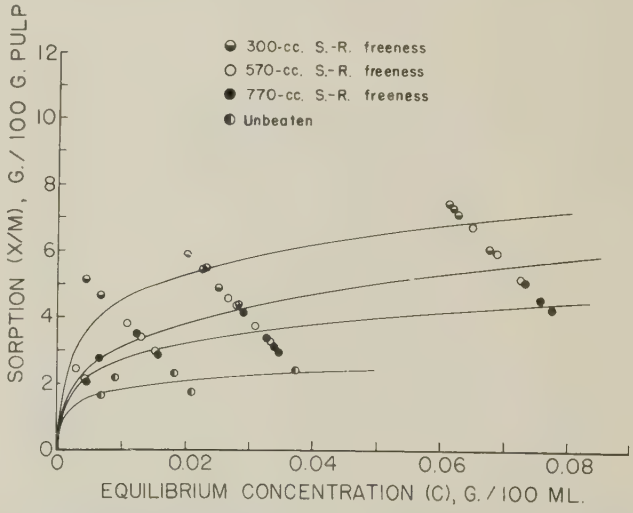

Fig. 2. Effect of concentration of 400-cp. methylcellulose on sorption by a bleached sulphite pulp using viscometric analysis at 25°C.

of pulp, t is the time in hours, and a and n are constants given in Table II for various sorption conditions. The constant a increases with the degree of beating and with increasing concentration. Severe beating seems to increase the constant very little from the value obtained with slight beating. The rate of sorption data did not fit a variety of equations from the literature,

and the formula chosen is empirical. The formula is also parabolic in form, and applies only to the early

Table II. Rate Equation[a] Constants for Cotton Linters and Bleached Sulphite Pulps

Pulp	Constant a	Constant n
Cotton linters (0.005 g./100 ml. initial concentration)		
Unbeaten	0.06	0.17
655 ml. S.-R. freeness	0.29	0.12
335 ml. S.-R. freeness	0.35	0.15
Bleached sulphite (770 ml. S.-R. freeness)		
0.0150 g./100 ml. Initial concentration	0.49	0.12
0.0500 g./100 ml. Initial concentration	0.95	0.10

[a] For the equation $X/M = ac^n$.

stages of sorption because a constant sorption cannot be obtained from such a mathematical equation.

EFFECT OF BEATING ON SORPTION

Bleached Kraft Pulp

In Figs. 2 and 3, the results obtained with bleached sulphite pulp at different degrees of beating using 400-cp. methylcellulose at 25°C. are given. The curves were obtained by fitting the data to a Freundlich adsorption isotherm of the form $X/M = ac^n$, where X/M is the sorption in grams per 100 grams of pulp, c is the equilibrium concentration in grams per 100 ml., and a and n are constants. Best straight lines were drawn through the data on log-log plots of equilibrium concentration versus sorption. A study of Figs. 2 and 3 indicates that the data fit such an equation reasonably

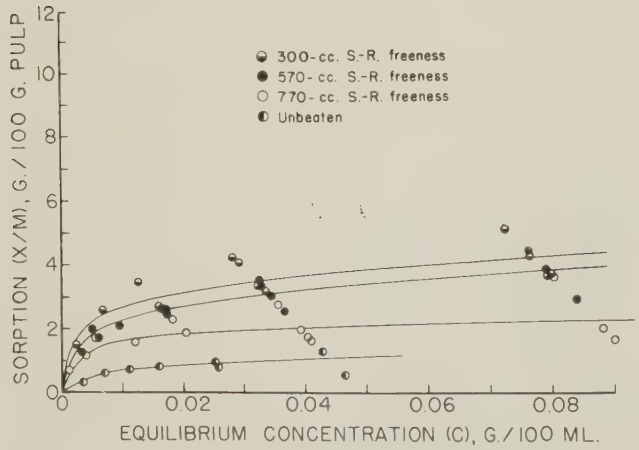

Fig. 3. Effect of concentration of 400-cp. methylcellulose on sorption by a bleached sulphite pulp using anthrone analysis at 25°C.

well although there is considerable variability in the analytical results.

The data obtained with bleached sulphite pulp also fit moderately well an adsorption isotherm of the Langmuir type which has the form of a hyperbola $c/(X/M) = 1/ab + c/b$, where X/M is sorption in grams per 100 grams pulp, c is the equilibrium concentration in grams per 100 ml., and a and b are constants. This equation has an advantage in sorption studies, because the curve becomes essentially parallel to the x-axis indicating a sorption saturation, while the parabolic Freundlich curve does not. The Freundlich isotherm is, therefore, applicable only to data which are not too near the region of saturation.

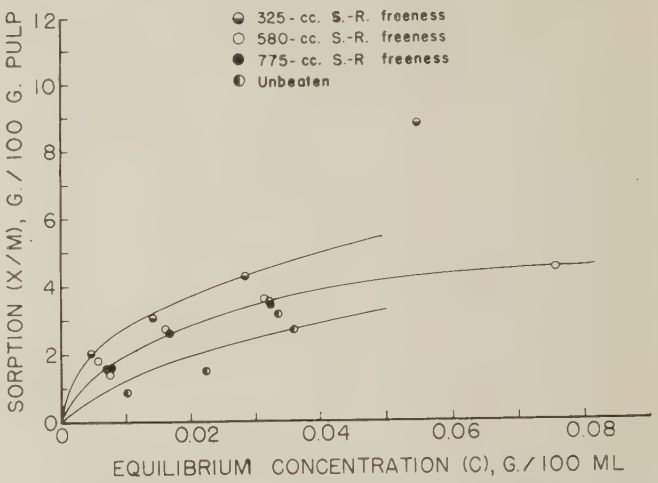

Fig. 4. Effect of concentration of 400-cp. methylcellulose on sorption by a bleached kraft pulp using viscometric analysis at 25°C.

Figures 2 and 3 show that the analytical results obtained with the anthrone method and with the viscometric method agree very poorly. In general, the viscosity method gives sorptions which are one and a half to two times those obtained with the anthrone method. A detailed discussion of the possible reasons for this discrepancy was given in a previous paper (*1*).

The data plotted in Figs. 2 and 3 indicate clearly that sorption is a function of beating and increases with the degree of pulp treatment. In the case of both analytical techniques, the sorption by well-beaten pulp is three to four times that for the unbeaten pulp. Sorption increases rapidly at first with increasing equilibrium concentration and then increases less rapidly as higher concentrations are approached. The highest concentration of additive used (0.1% or 20% on the pulp at 0.5% consistency) was not sufficient to saturate the pulp, although saturation was more nearly obtained with the anthrone than with the viscosity method. However, it is obvious that the pulp is nearly saturated at 20% of additive and little would be gained by increasing the methylcellulose to pulp ratio.

The reader may be interested in the straight lines of negative 45° slope formed by the groups of points in Figs. 2 and 3. These straight lines result from the method of computation of the sorption and intersect the x-axis at the initial methylcellulose added on the pulp. The lines have no other significance.

Bleached Kraft Pulp

In Fig. 4 are given the results of runs with bleached kraft pulp at different degrees of beating. The effect of beating in the case of the bleached kraft is much less pronounced than with the bleached sulphite pulp,

although sorption quite definitely increases with beating. There is no significant difference between sorption by the 775 and the 580-ml. S.-R. freeness pulps, and the well-beaten pulp sorbs only about one and a half times the methylcellulose retained by the unbeaten stock. These results are necessarily tentative, because of the limited data available. Additional runs would undoubtedly alter levels but not trends.

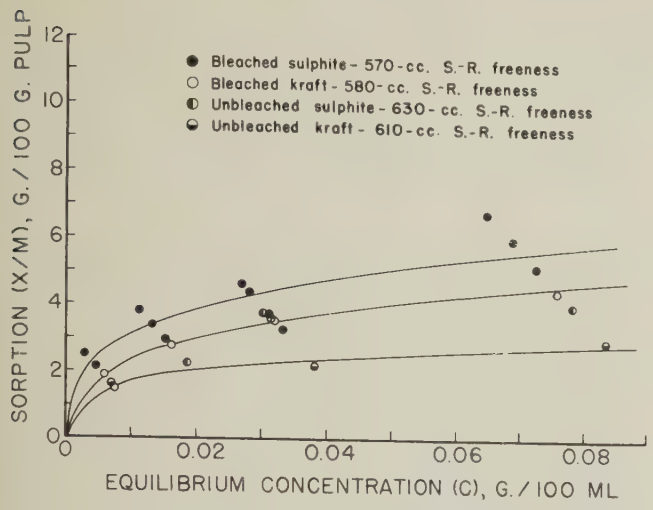

Fig. 5. Sorption of 400-cp. methylcellulose by different pulps at similar degrees of beating using viscometric analysis at 25°C.

Cotton Linter Pulp

In the study of cotton linters, it was found that the agreement between the anthrone and viscosity analytical methods was much better than for bleached sulphite or bleached kraft pulps. For both methods, sorption increased with beating but there was no effect of beating to less than 470-ml. S.-R. freeness. The anthrone method indicated that well-beaten pulps sorb about four to five times the methylcellulose sorbed by an unbeaten pulp or a maximum of 2 to 2.5%. The viscosity data were too meager to permit conclusions on the ratio of well-beaten to unbeaten sorption.

Unbleached Kraft and Unbleached Sulphite Pulps

For the unbleached pulps the viscometric analytical method was used exclusively, and no correction was required for residual viscosity. An unbeaten and one beaten sample (about 600-ml. S.-R. freeness) were run for each pulp. Sorption was found to increase with beating, and both unbleached kraft and unbleached sulphite sorbed about three times the methylcellulose at the 600-ml. S.-R. freeness level than when unbeaten. The maximum sorption for the unbleached kraft was about 3%, and for the unbleached sulphite, 4%.

Sorption Constants

Table III gives the Freundlich isotherm constants for the pulps studied in the present investigation. A possible physical interpretation of these constants will be mentioned in the discussion of results.

COMPARISON OF SORPTION BY PULPS AT SIMILAR DEGREES OF BEATING

The relative sorptivity of papermaking pulps for methylcellulose is of interest, both from a theoretical and from a practical viewpoint. In Figs. 5 and 6, the various pulps used in this study are compared at similar degrees of beating. With viscometric analysis at approximately 600-ml. S.-R. freeness, the bleached sulphite pulp sorbed methylcellulose to a greater extent than the kraft or unbleached sulphite pulps. Bleached kraft and unbleached sulphite sorbed about the same amount, just significantly less than the bleached sulphite. Unbleached kraft, however, showed a lower sorptivity, which corresponded roughly to unbeaten bleached sulphite.

Table III. Freundlich Sorption Isotherm Constants
Viscometric analysis; 400-cp. methylcellulose

Degree of beating	*25°C. Constant a*	*Constant n*
Bleached Sulphite Pulp		
Unbeaten	4.5	0.20
770 S.-R.	8.1	0.24
570 S.-R.	12.2	0.30
300 S.-R.	13.3	0.24
Bleached Kraft Pulp		
Unbeaten	19.0	0.59
775 S.-R.	22.1	0.54
580 S.-R.	13.6	0.41
325 S.-R.	18.2	0.39
Unbleached Sulphite Pulp		
Unbeaten	...	...
630 S.-R.	10.8	0.34
Unbleached Kraft Pulp		
Unbeaten	1.8	0.20
610 S.-R.	5.3	0.25
Cotton Linters		
Unbeaten	1.0	0.23
470 S.-R.	5.3	0.25
335 S.-R.	5.3	0.25

In Fig. 6, bleached sulphite pulp is compared with cotton linters and bleached kraft at about 300-ml. S.-R. freeness using viscometric analysis. These data show that bleached sulphite and bleached kraft have approximately the same relative sorptivities as at 600-ml. S.-R. freeness, and that cotton linters retain much less methylcellulose than the other pulps.

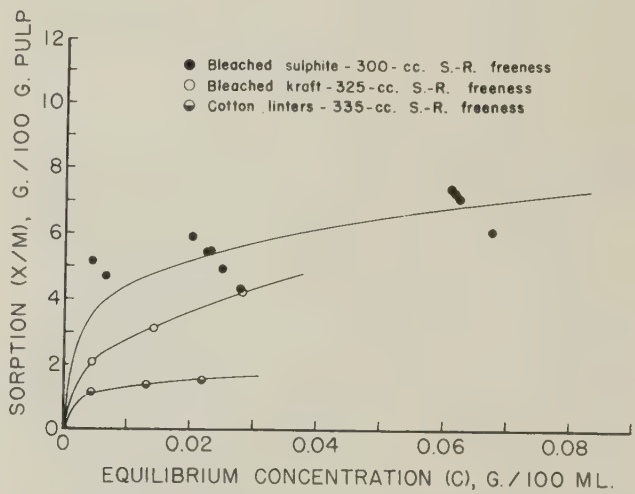

Fig. 6. Sorption of 400-cp. methylcellulose by different pulps at similar degrees of beating using viscometric analysis at 25°C.

The pulps studied may be arranged in the following order of sorptivity at similar degrees of beating. Bleached sulphite has the greatest sorptivity followed closely by bleached kraft and unbleached sulphite, which are approximately equal. From comparisons with bleached sulphite, it was concluded that cotton

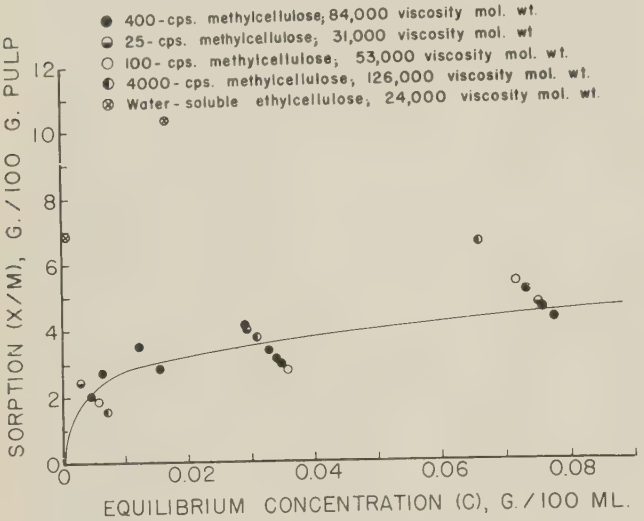

Fig. 7. Effect of molecular weight on sorption by 770-ml. S.-R. freeness bleached sulphite pulp using viscometric analysis at 25°C.

linters showed greater sorptivity than unbleached kraft, and that these latter two pulps retained much less additive than the other pulps.

EFFECT OF MOLECULAR WEIGHT OF METHYLCELLULOSE ON SORPTION

The effect of molecular weight on sorption is a particularly interesting variable, since the efficacy of the viscometric method of analysis depends on the absence of selective retention of a given molecular species by the pulps under investigation. In Fig. 7 are presented data obtained by the viscometric analytical technique for 770-ml. S.-R. freeness bleached sulphite pulp, with a curve drawn through the 400-cp. methylcellulose data. None of the viscosity grades of methylcellulose deviate significantly from the values for the 400-cp. sample, except for a single point (at 0.066 gram per 100 ml. concentration) for the 100-cp. methylcellulose, which is an apparent anomaly.

Similar results with respect to the effect of molecular weight of methylcellulose were obtained with anthrone analysis. However, while the viscosity analytical technique showed a much greater ethylcellulose sorption than that obtained for methylcellulose, the anthrone method gave an ethylcellulose sorption curve only slightly above that for methylcellulose. In view of the very high ethylcellulose sorptions obtained viscometrically, and because of the low molecular weight and hence low specific viscosity of the ethylcellulose, the viscometric results must be questioned.

It was concluded that sorption of methylcellulose by pulps is not accompanied by a selective retention of particular molecular species within the limits of experimental error, and that ethylcellulose is sorbed to a slightly greater extent than methylcellulose.

EFFECT OF ROSIN AND ALUM ON SORPTION

In determining the effect of rosin and alum on sorption of methylcellulose, the 570-ml. S.-R. freeness bleached sulphite pulp was used with the 400-cp. grade methylcellulose. The rosin used was a commercial (grade F) wood rosin containing 30% free rosin and 70% solids. For experiments with rosin alone, 1 ml. of rosin solution was added to the methylcellulose solution before addition of the pulp to give 4% on the pulp. For alum alone, 1.5 ml. of alum solution was added to the methylcellulose solution to give 6% alum on the pulp. For experiments employing both rosin and alum, the rosin was first added to the methylcellulose solution, followed by the pulp, and then the alum.

Rosin and alum were found to have no effect on the anthrone analytical result, but reduced the Arrhenius viscosity constant (see Table I) slightly, presumably by partial collapse of the hydration layer surrounding the methylcellulose molecules. The Arrhenius viscosity equation was obeyed in an excellent manner, however.

The experiments indicated that there is no effect of rosin or alum alone or in combination with each other, at the levels indicated above. However, it was found that increasing concentrations of alum alone increased sorption greatly. At a level of 6% alum on the pulp or 0.0005 molar concentration surrounding the pulp, there was no increase in sorption compared to pulp without alum. At a level of 66% alum on the pulp or 0.005 molar concentration, sorption was over twice that obtained with no alum. At a level of 660% alum on the pulp or 0.05 molar concentration, sorption was three times that resulting with no alum present. The higher concentrations of alum evidently produced a

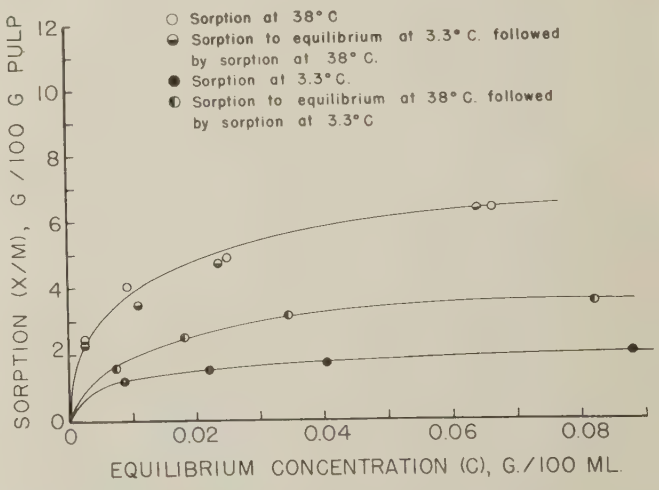

Fig. 8. Temperature hysteresis; 400-cp. methylcellulose sorbed on 570-ml. S.-R. freeness bleached sulphite pulp using anthrone analysis

"salting out" effect on the methylcellulose molecules, making them less soluble and more readily retained by the pulp.

SORPTION REVERSIBILITY

Effect of Concentration

The reversibility of a sorption system can give important clues to the nature of the forces involved. A

"reversible" process is one which can be reversed by making infinitesimal changes in conditions of state—for example, concentration or temperature. In the case where a lag exists in the response of the process to the changes in conditions, "hysteresis" is said to occur. A process is irreversible if it does not respond to reverse changes in conditions but goes essentially in one direction only.

In studying the effect of concentration changes on equilibrium sorption, distilled water was added to a system at equilibrium in order to dilute the methylcellulose. After rotation for 9 days, the sorption was again computed after analysis and allowance for the initial sample removed. Table IV gives the results of this study.

Table IV indicates that the initial and final sorptions agree fairly well, considering the analytical variability (previously discussed) of beaten pulps, and noting that the final sorption values are nearly equally distributed about the initial values. In particular, the viscometric sorptions agree well. These data, therefore, support the conclusion that the sorption of methylcellulose by pulps is irreversible with respect to concentration changes. In short, methylcellulose will adsorb as a function of the equilibrium concentration, but will not desorb when this concentration is reduced.

Effect of Temperature

Figure 8 gives the results of experiments designed to show the effect of temperature on sorption reversibility. A run was made at 38°C. and another at 3.3°C. After sampling to determine the equilibrium concentration, the 38°C. samples were placed in the 3.3°C.

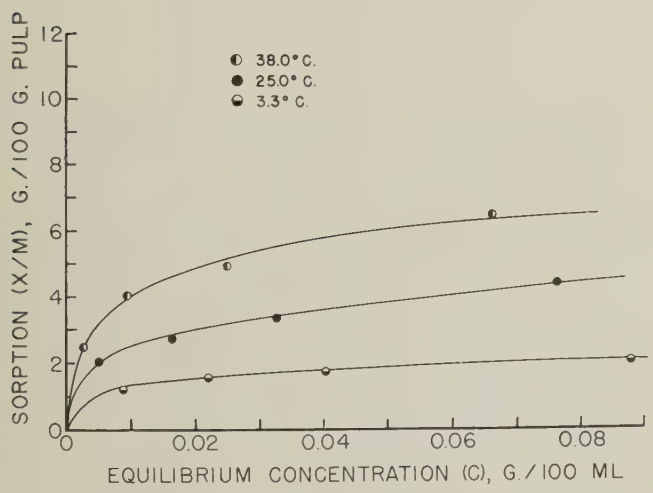

Fig. 9. Effect of temperature on sorption of 400-cp. methylcellulose by 570-ml. S.-R. freeness bleached sulphite pulp using anthrone analysis

temperature environment, and the samples equilibrated at 3.3°C. were rerun at 38°C. It will be noted from Fig. 8 that sorption increases with increasing temperature, and appears to be a function of the particular temperature reached (and independent of the path) for ascending temperatures. However, for descending temperatures an hysteresis effect is observed, since the 38°C. run, when rerun at 3.3°C., had a higher sorption than the initial 3.3°C. run. It was concluded that sorption is not completely irreversible with respect to temperature as it is with concentration, but shows an hysteresis effect.

EFFECT OF TEMPERATURE ON SORPTION

In addition to Fig. 8, the data plotted in Fig. 9 show the effect of temperature on the retention of 400-cp.

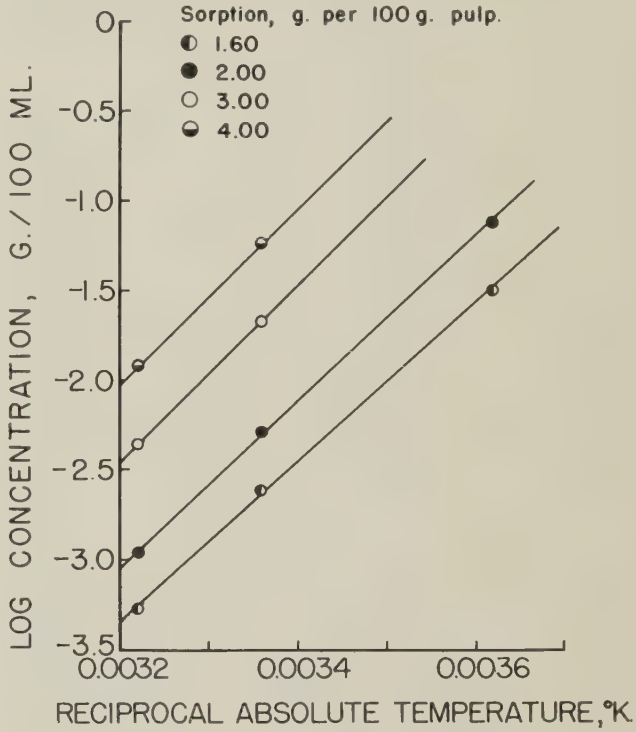

Fig. 10. Effect of temperature on sorption of 400-cp. methylcellulose by 570-ml. S.-R. freeness bleached sulphite pulp using anthrone analysis; sorption isostere

methylcellulose by 570-ml. S.-R. freeness bleached sulphite pulp, using the anthrone analytical method. Some experiments of this nature were also made using the viscometric analysis and these served to verify the anthrone results.

From Figs. 8 and 9, the marked effect of temperature on sorption can be readily seen. Retention increases with increasing temperature, in contrast to a classical type adsorption in which sorption decreases with increasing temperature because of the greater kinetic energy of the molecules being sorbed. The effect of temperature is even more pronounced than the effect of beating (Figs. 2–6), and raising the temperature from 25 to 38°C. resulted in doubling the sorption as measured by the viscosity technique and increasing it 50% as determined with anthrone.

Date from the study of the effect of temperature were plotted on log-log graph paper, and the best straight line was drawn through the points in the manner previously described for fitting the data to a Freundlich isotherm. From this plot values of equilibrium concentrations for the three temperatures at a given sorption were obtained. These data were substituted

in the Clausius-Clapeyron equation to obtain the differential heat of retention.

$$Q = -\Delta H = (RT_2T_1/T_2 - T_1) \ln C_2/C_1$$

where

Q = heat evolved or absorbed
ΔH = heat of retention
T_1, T_2 = absolute temperatures corresponding to equilibrium concentrations C_1 and C_2 at a selected sorption
R = gas constant

It may be seen from this equation that a plot of log C versus the reciprocal absolute temperature will give a straight line whose slope multiplied by the gas constant R, and the factor for conversion of natural logs to common logs will give ΔH. Such a plot is given in Fig. 10 with the lines corresponding to the selected sorptions which are tabulated in the lower right of the figure. In Table V the slopes of the various lines are given, together with the calculated heats of retention. For comparision, the heats calculated from the viscosity data are included. The agreement between methods is good, considering the probable errors in the analytical techniques. The average heat of retention for the anthrone method was found to be 21,500 cal. per mole.

Experimental runs using 300-ml. S.-R. freeness bleached sulphite pulp and the 400 and 25-cp. grades of methylcellulose were also made. Although these data were somewhat meager (only two points were run on the 38 and 3.3°C. curves), they gave heats of retention approximating those obtained from the 570-ml. S.-R. pulp. It was concluded that heats of retention varied little with the degree of beating of the pulp or with the molecular weight of the methylcellulose.

Since retention of methylcellulose increases with increasing temperature, in a manner similar to the increase in adhesion of copolymers to cellulose with increase in temperature, a classical-type adsorption phenomenon cannot be exclusively involved. A line of reasoning similar to that of Hofrichter and McLaren (*20*), in their investigation of copolymer adhesion, was followed in obtaining an actual heat of adsorption. These investigators postulated that the heat of adhesion was equal to an exothermic heat of adsorption and an endothermic heat of fluidity or cohesion. The evolution or absorption of heat on adhesion depends on the relative magnitudes of cohesion and adsorption. Hofrichter and McLaren found the adhesion process to be endothermic and concluded that the heat of fluidity or cohesion was greater than the heat of adsorption.

Hofrichter and McLaren worked with hot melts in their investigations and the idea of heat of fluidity or cohesion is hardly applicable to high polymer solutions in good solvents. As will be discussed later, there is reason to believe that a gelation of methylcellulose occurs at the fiber solution interface on sorption of methylcellulose from water solution. Therefore, the heat of gelation was substituted for Hofrichter and McLaren's heat of cohesion. Thus, the heat of retention was made equal to the heat of adsorption plus

Table IV. Concentration Reversibility

Analytical method	*Freeness, ml. S.-R.*	*Initial equilibrium concentration, g./100 ml.*	*Initial sorption, g./100 g. pulp*	*Final equilibrium concentration, g./100 ml.*	*Final sorption, g./100 g. pulp*
		Bleached Sulphite			
Anthrone	770	0.0058	1.72	0.0046	1.02
		0.0355	2.77	0.0173	2.56
		0.0806	3.60	0.0400	2.86
	570	0.0060	1.78	0.0036	1.48
		0.0171	2.51	0.0078	2.61
		0.0343	3.00	0.0139	3.87
		0.0790	3.88	0.0375	3.83
Viscosity	570	0.0108	3.80	0.0047	3.63
		0.0277	4.35	0.0106	4.40
	300	0.0042	5.14	0.0012	5.24
		0.0200	5.90	0.0070	6.11
		Cotton Linters			
Anthrone	795	0.0021	0.56	0.0017	0.58
		0.0017	0.58	0.0013	0.58
	635	0.0169	1.51	0.0088	1.62
	470	0.0034	1.31	0.0017	1.35
		0.0112	1.72	0.0055	1.94
	335	0.0039	1.20	0.0022	1.21
		0.0118	1.60	0.0060	1.76

Note: In the viscosity analytical method, the residual viscosity was considered to be diluted by the distilled water in the same proportion as the methylcellulose.

Table V. Heat of Retention of Methylcellulose

Sorption g./100 g. pulp	*Slope log concentration-reciprocal temperature curve*	ΔH_R, *cal./mole*
	Anthrone Method	
1.60	4400	20,200
2.00	4600	21,100
3.00	4930	22,600
4.00	4870	22,300
Av.		21,500
	Viscosity Method	
4.00	3870	17,700
5.00	4070	18,600

the heat of gelation. Heats of gelation of methylcellulose were obtained by application of the Clausius-Clapeyron equation to gelation temperatures obtained by the Dow Chemical Co. (*29*). These data are listed in Table VI together with the calculated molar heat of gelation and the specific heat of gelation in calories per gram, The specific heat of gelation was obtained by dividing the molar heat by the molecular weight obtained from data furnished by Dow. The gelation temperatures and molecular weights are averages of a number of batches of the Methocel grades listed.

From Table VI it may be seen that the heats of gelation are relatively constant with respect to molecular weight but decrease with decreasing concentration. The values from 2 to 5% concentration were used in computing the heat of sorption; the average molar heat of gelation was taken as 29,700 cal. per mole. (It is possible that a somewhat larger heat of gelation exists for the low concentrations of methylcellulose used in the sorption studies reported here. However, the gelation temperature would be experimentally difficult to determine because actual agglomeration of methylcellulose does not occur for dilute solutions even at the boiling temperature. Perhaps a light-scattering technique could be used. In any event, the error in using the heat of gelation calculated above does not appear to be great.)

Table VI. Heat of Gelation of Methocel[a]

Methocel grade	*Concentration, % by wt.*	*Gelation temperature, °C.*	ΔH, *cal. mole*	ΔH, *cal./gram*
4000	2.6	51.4	32,600	0.23
	3.0	50.5		
25	2	55.0	29,600	0.78
	5	48.5		
15	2	59.0	26,200	0.86
	5	51.5		
	5	51.5	11,800	...
	10	40.0		
10	2	58.5	30,200	1.19
	5	52.0		
	5	52.0	13,400	...
	10	41.5		

[a] Computed from data in the Dow Methocel brochure (*29*), Figs. 6–9, pp. 47–50.

The form of the Clausius-Clapeyron equation used in computing heats of gelation was that employed by Meyer and van der Wyck (*30*):

$$Q = \Delta H = RT_2T_1/T^2 - T_1 \ln W_2/W_1$$

where W_1 and W_2 are the concentrations by weight of solutions saturated at absolute temperatures T_1 and T_2, and R = gas constant.

The equation relating heats of retention, adsorption, and gelation is:

$$\Delta H_r = \Delta H_s + \Delta H_g$$

where the subscripts refer to retention, sorption, and gelation. Substituting the experimentally determined heats of retention and gelation, the value for the heat of sorption is found to be:

$$\begin{aligned} \Delta H_s &= \Delta H_r - \Delta H_g \\ &= 21{,}500\text{–}29{,}700 \\ &= -8200 \text{ cal. per mole (exothermic)} \end{aligned}$$

DISCUSSION

The study of the effect of temperature on sorption brought out the inverse effect of temperature increase, in which retention is increased rather than decreased as found for a classical adsorption such as gases on charcoal. Where an endothermic retention process exists, another process which possesses a greater endothermic heat than the exothermic adsorption process must simultaneously take place. It was hypothesized that the process of methylcellulose retention consists of an endothermic gelation process occurring between adjacent methylcellulose molecules near the fiber surface and an exothermic adsorption process occurring between methylcellulose molecules and the fiber surface itself. The heat of gelation was determined from gelation temperatures and the heat of adsorption from the difference between the heats of retention and gelation. The heat of adsorption was determined to be −8200 cal. per mole (exothermic) which is the right order of magnitude for hydrogen bonding (*18*).

The results obtained with pulps beaten to various degrees of freeness indicated the sorption for well-beaten pulps was approximately three to four times that of unbeaten pulps. Since freeness is a measure of surface area, and the surface area of pulps increases three to five times with beating (*31*, *32*), it can be concluded that sorption of methylcellulose is a surface phenomenon and that the term "adsorption" is applicable to this process. The increase of retention obtained with beating agrees with the findings of Obermanns for sorption of hemicelluloses and of the Dow Co. for sorption of Methocel. Steric considerations lend weight to this conclusion. The reported size of the methylcellulose molecule (7 to 9 A diameter) is of the same order as the upper limiting size (18 A) for dyes which dye cotton. More than a superficial penetration of cellulose fibers by methylcellulose molecules is, therefore, unlikely.

Gyani (*33*) made a very interesting attempt to relate Freundlich adsorption constants to a general adsorption mechanism. (Freundlich constants for the pulps studied are reported in Table III.) Gyani showed that the Freundlich exponent n should be equal to $^2/_3$ for an adsorption which takes place anywhere on a given surface. It was further pointed out that for $n = {}^1/_3$, the solute should be confined to certain lines in the solid phase, and these lines may be identified with the exposed edges of microcrystals of the solid phase or scratches or imperfections in them. It is interesting to note that the Freundlich exponents for most of the pulps studied are quite close to the value of 0.33 specified as indicative of line adsorption.

The sorptivity of different varieties of pulps seemed to correspond fairly well with the known hydrophilic nature of the fiber surface and the ease of beating. Bleached sulphite had the greatest sorptivity of the pulps tested, followed closely by bleached kraft and unbleached sulphite. Cotton linters were next in order of sorptivity with unbleached kraft last. It may be postulated that the hydrophilic nature of the pulp surface plays an important role in the retention of water-soluble cellulose ethers by pulps; the more hydrophilic pulps retain greater amounts of additive.

THEORY OF SORPTION

At a given temperature and a given concentration, a molecule of water-soluble cellulose ether (methylcel-

lulose will be particularly discussed) in water solution is in equilibrium with water molecules entering and leaving the outer layers of the hydration or solvation shell. Raising the temperature or increasing the concentration will shift the equilibrium and decrease the thickness of the solvation shell. If wood pulp is introduced isothermally into the system methylcellulose–water, the methylcellulose molecules begin to strike the surface of the cellulose (itself having a hydration layer). Most of the methylcellulose molecules do not adhere to the cellulose because of the protection of the respective hydration shells. Occasionally, methylcellulose molecules having a much higher energy than the average, strike the cellulose surface at a point where the respective hydration shells are momentarily thin, and hydrogen bonds are formed with the pulp through "bridges" of several water molecules. If the methylcellulose molecules are close enough to the pulp to hydrogen bond directly or through a single water molecule, the adhesion is a relatively stable one and only a few methylcellulose molecules are able to escape.

As additional methylcellulose molecules strike the surface of the pulp and form stable bonds, the point is rapidly reached where hydrogen bonding between adjacent molecules begins to take place. Ordinarily, when such bonds form in solution, they are rapidly broken because of the mobility of the respective molecules. Now, however, the bonding molecules are greatly restricted through attachment at some point to the cellulose surface, and the co-molecular bonds are much more stable. As other molecules continue to adhere to the pulp, the surface becomes more crowded and molecular mobility is further reduced which increases the stability of the co-molecular bonds. Additional molecules find it difficult to penetrate the adhering methylcellulose at the pulp surface, and bond to adjacent molecules. The rate of sorption continues to decrease steadily. At equilibrium, there exists at the pulp surface and for some distance from the surface, a more or less loose association of methylcellulose molecules, analogous to the gel formed on heating a methylcellulose solution of sufficient concentration in water. At low equilibrium concentrations, the gel structure is less rigid and compact than at higher concentrations.

Increasing the concentration isothermally results in a decreased hydration shell, allowing a greater number of methylcellulose molecules to possess sufficiently thin hydration shells and the requisite energy to approach the pulp surface and adhere or cohere—in short, the rate of sorption increases. As equilibrium is approached, the gel structure at the fiber surface becomes more compact and rigid than at lower concentrations because of the greater number of molecules cohering—i.e., sorption is increased. This increased sorption is the result of the decreased hydration shell caused by bulk concentration effects, thus allowing a closer packing near the fiber surface. As the concentration is increased, saturation of the fiber results (at about 0.1 gram per 100 ml.), because the packing near the fiber surface becomes so great that additional molecules cannot penetrate the gellike aggregation.

The retention of methylcellulose is irreversible with respect to isothermal concentration changes because of the reduced mobility of the molecules near or at the fiber surface, which prevents rehydration and dispersion. This situation may be analogous to the difficulty found in dispering methylcellulose unless it is first soaked in hot water. The gellike lumps which form around unsoaked lumps of methylcellulose in cold water are not easily penetrated. Methylcellulose which has gelled is also not readily redispersed. Data from the literature on the sorption of the starch amylose fraction a-d of Dow Methocel also suggest an irreversible sorption with respect to concentration, so that such behavior is not unusual for straight-chain carbohydrates.

Increasing the sorption temperature increases the retention of methylcellulose, because the water shell is thinner and the approach of methylcellulose molecules to the fiber surface and adjacent molecules is made easier. The reverse takes place at low temperatures where the retention is less. As mentioned previously, the predominant process is one of gelation between cohering molecules near the fiber surface and this effect overshadows the sorption process. Decreasing the temperature after equilibrium has been established, results in removal of methylcellulose from the sorbed layers, in contrast to the stability of the sorbed material upon isothermally reducing the concentration of methylcellulose. Although decreasing the temperature decreases the mobility of the retained molecules, this is more than offset by the tendency to rehydrate and increase the thickness of the water envelope which forces the gel structure at the fiber surface to expand and tear loose the greater part (but not all) of the retained methylcellulose. The final retention of methylcellulose is still greater than could have been obtained had the final temperature been approached from below. An hysteresis effect exists.

Experimental evidence is entirely lacking as to the orientation of retained methylcellulose molecules at the fiber surface but it may be fruitful to speculate. In the extreme, two orientations can be imagined. In the one case, all the methylcellulose molecules could be arranged perpendicular to, and with one end attached to, the cellulose surface with the other end free to hydrogen bond with adjacent molecules. In the other case, methylcellulose molecules could be arranged parallel to the fiber surface. Each of these possibilities will be examined.

Methylcellulose molecules arranged perpendicular to the fiber surface would permit all molecules retained to be bonded directly to the fiber surface. Calculations show that each molecule would occupy about 200 sq. A for (1) the 400-cp. methylcellulose, (2) a retention of 2 grams per 100 grams pulp (an average for unbeaten sulphite and kraft pulps) and (3) an assumption of 3000 sq. cm. per gram for microscopic, specific, unbeaten pulp surface (*34*). This means that each methylcellulose molecule would occupy a space 14 by 14 A. Such dimensions should be compared with a molecular width of 8 A (*8*). This would suggest a solvation shell 3 A thick, which is the right order of magnitude for hydrogen bonding.

The idea of a perpendicular orientation is supported by the probable thinner solvation shell at the chain ends of the relatively rigid methylcellulose molecule.

A thinner shell would permit closer approach to the pulp surface at chain ends. However, the number of polar groups at or near chain ends is limited and this fact constitues an argument against perpendicular orientation. Another experimental finding difficult to explain by means of a perpendicular orientation is the absence of a molecular weight effect on sorption in the range studied. Perpendicular orientation suggests equal *numbers* of molecules sorbed, which would mean an increasing *weight* of sorbate as average chain length increases.

A parallel orientation of retained methylcellulose would provide more polar groups for hydrogen bonding to the pulp surface and is supported by the results of Gyani (loc. cit.) on Freundlich adsorption constants. The heat of adsorption of −8200 cal. per mole (exothermic) suggests that there is one gram-atom of hydrogen bonding per mole or about one hydroxyl group per methylcellulose chain retained by the pulp involved in true adsorption. Calculations for a parallel orientation, assuming the width of a methylcellulose chain as 8 A and the length as D.P. × 5.15 A, and using a microscopic unbeaten pulp specific surface of 3000 sq. cm. per gram (*34*), indicate that only one out of 90 molecules retained by the pulp are at the pulp surface, for a retention of 2 grams per 100 pulp (an average for the unbeaten sulphite and kraft pulps). Thus, 90 hydroxyl groups per methylcellulose chain are involved in true adsorption at the pulp surface or one hydroxyl group per five monomer units for the 400-cp. methylcellulose with a D.P. of 445 (Table I). The remainder of the methylcellulose molecules are probably involved in gelation bonding with an endothermic heat which means that more hydrogen bonds are broken in desolvation than are reformed on gelation.

Increasing the molecular weight of high polymers increases the thickness of the solvation layer and reduces the ease with which the solvated molecule can approach adjacent molecules and the fiber surface. However, the greater length of molecule may provide more opportunities for bonding and this factor apparently offsets the greater thickness of the hydration layer in the range of molecular weights studied so that no effect of molecular weight on sorption was noted. It has been noted for many high polymer systems that there is very little change in properties with increasing molecular weight above a molecular weight of 10,000, and all the cellulose ethers studied had molecular weights above this level.

The presence of highly hydrated anions, such as sulphate ion in sufficient concentration, exerts a dehydrating effect on the methylcellulose molecule. The relative viscosity for a given concentration is reduced in such a salt solution and the retention of methylcellulose is greatly increased; this may be associated with a smaller hydration shell and better packing at the fiber surface.

One further remark should be made about the slow rate of methylcellulose sorption. For endothermic processes, the heat of activation must at least be equal to the heat of reaction. In the over-all methylcellulose retention process, therefore, the heat of activation must be at least 21,500 cal. per mole. This heat of activation lies in the upper part of the range which Glasstone (*35*) describes as activated adsorption. This author further states that the rate of adsorption is usually relatively slow and irreversibility not uncommon.

LITERATURE CITED

1. Shriver, E. H., Webb, M. B., and Swanson, J. W., *Tappi* 33, No. 12: 578–586 (Dec., 1950).
2. Haskins, J. F., Cellulose Ethers of Industrial Significance. In Pigman and Wolfram, "Advances in Carbohydrate Chemistry," vol. 2, pages 279–294, New York, Academic Press, 1946.
3. Wakeman, R. L., "The Chemistry of Commercial Plastics," page 687, New York, Reinhold, 1947.
4. Young, A. E., and Kin, M., Methylcellulose. In Alexander, "Colloid Chemistry," vol. 6, pages 926–933, New York, Reinhold, 1946.
5. Worden, E. C., "Technology of Cellulose Ethers," vol. 4, pages 1426, 2465 *et seq.*, Millburn, N. J., Worden Laboratory and Library, 1933.
6. Tice, L. F., *Drug and Cosmetics Ind.* 52: 3, 273 (1943) as reported by (*10*). See also (*3*), page 35.
7. Signer, R., and Liechti, J., *Helv. Chim. Acta* 21: 530 (1938).
8. Signer, R., and Tavel, P. V., *Helv. Chim. Acta* 21: 535 (1938).
9. Edge, S. R. H., *Paper Makers' Assoc. Gt. Brit. & Ireland, Proc. Tech. Sect.* 21: 213 (1940).
10. Musser, D. M., and Engel, H. C., *Paper Trade J.* 115, No. 8: 33–35 (Aug. 20, 1942). See also Musser, D. M., and Engel, H. C., U. S. pat. 2,393,553 (Jan. 22, 1946).
11. Collins, R. E., The Effect of Beater Additives on the Physical Characteristics of Sulfite Pulp. Senior Problem. Syracuse, N. Y., New York State College of Forestry, 1949.
12. Topping, *The Paper-Maker and British Paper Trade J.* 117, No. 5: 337 (May, 1949).
13. Unpublished data, the Dow Chemical Co., Midland, Mich.
14. Jayne, J. E., Tongren, J. C., and Jackson, D. T., *Tappi* 33: 25–32 (1950).
15. Erspamer, A., *Paper Trade J.* 110, No. 24: 33–38 (June 13, 1940).
16. Broadbent, F. D., and Harrison, H. A., *Paper Makers' Assoc. Gt. Brit. & Ireland, Proc. Tech. Sect.* 21: 213 (1940).
17. Dixson, H. P., Jr., *Tech. Assoc. Papers* 23: 192–199 (1940).
18. Mark, H., Adhesion. In Proceedings of 1948 Plastics Conference, Plastics Committee of TAPPI, pages 51–55, New York, TAPPI, 1948.
19. McLaren, A. D., *J. Polymer Sci.* 3: 652 (1948).
20. Hofrichter, C. H., Jr., and McLaren, A. D., *Ind. Eng. Chem.* 40: 329 (1948).
21. McLaren, A. D., and Seiler, C. J., *J. Polymer Sci.* 4: 63 1949).
22. Samec, M., *Ber.* 73A: 88 (1940).
23. Pacsu, E., and Mullen, J. W., 2nd, *J. Am. Chem. Soc.* 63: 1168–1169 (1941).
24. Obermanns, H. E., *Paper Trade J.* 103, No. 7: 83–91 (Aug. 13, 1936).
25. March, R. E., *Tech. Assoc. Papers* 31: 240–246 (1948).
26. Unpublished data, the Dow Chemical Co., Midland, Mich.
27. Mantell, C. L., "Adsorption," 1st ed., New York, McGraw-Hill, 1945, 386 pages.
28. Cannon, M. R., and Fenske, M. R., *Oil and Gas J.* 33, No. 47: 52 (April 11, 1935); 34, No. 47: 45 (April 9, 1936).
29. The Dow Chemical Co., "The New Methocel Powdered Dow Methylcellulose," Midland, Mich., The Dow Chemical Co., 1949.
30. Meyer, K. H., and van der Wyck, A., *Helv. Chem. Acta.* 20: 1313 (1937).
31. Robertson, A. A., and Mason, S. G., *Pulp Paper Mag. Canada* 50, No. 13: 103–110 (Dec., 1949).
32. Browning, B. L., and Baker, P. S., *Tappi* 33: 99–101 (1950).
33. Gyani, B. P., *J. Phys. Chem.* 49: 442–453 (1945).
34. Stamm, A. J., Surface properties of cellulosic materials. Chap 13. In Wise, L. E., "Wood Chemistry," page 503, New York, Reinhold, 1944.
35. Glasstone, S., "Textbook of Physical Chemistry," 1st ed., New York, Van Nostrand, 1940, 1289 pages.

RECEIVED June 6, 1955. A portion of a thesis submitted in partial fulfillment of the requirements of The Institute of Paper Chemistry for the degree of Doctor of Philosophy from Lawrence College, Appleton, Wis., June, 1950. This work was carried out under the direction of J. W. Swanson. Presented at the 36th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19–22, 1951.

Weight Profile Measurement of Paper and Machine Clothing with a Beta Ray Scanner

JAMES D. SADTLER and H. BOROFSKY

Use of the beta ray scanner at Southland Paper Mills, Inc., to measure fiber weight distribution across the sheet in paper from machines has yielded excellent results. Weight profile measurements, recorded in graphic form and available in a short time, have enabled paper qualities and machine efficiencies to be improved and have been useful in making the proper choice in replacing some existing equipment. The scanner has also been used to establish wear patterns for machine clothing. Analysis of weight profiles for wet felts removed from machines has indicated corrective actions which should be taken to minimize felt wear and to assure uniform moisture distribution across the sheets. The latest application of the scanner is in the analysis of wear in fourdrinier wires. Results to date give hope for more highly technical and advanced control procedure for reaching and maintaining sheet qualities, for obtaining improved clothing life and machine efficiencies, and thus for improving the papermaker's economic position.

THE need for a means of measuring fiber weight distribution across the sheet in paper from machines has become more important as higher machine speeds and printing press speeds have come into use. From the papermaking angle, more uniform strength across the sheet is necessary to promote machine efficiencies and paper qualities comparable to those attained at lower speeds. This can be achieved if it is possible to measure the fiber weight distribution rapidly enough to use it as an aid in leveling out the sheet. From the printing angle, higher sheet quality is necessary as the demand for better printing increases, and this too can be achieved with a level sheet.

Beta ray gages have been used successfully for the past few years in spot locations to continuously measure coating weights and basis weights, with some traverse installations being made. These will work satisfactorily provided the sheet or coating is level across the machine, but it does not give enough information about the weight profile.

At present, no other methods of determining weight profiles are commercially available which do not consume considerable time and effort. Measurements have been made by cutting strips of paper into small units, weighing, and plotting to indicate the weight profile, but the process is so slow that the information upon completion is valueless in correcting machine variables.

A survey of weight distribution measuring devices, regardless of the means of determining weight, was conducted, and the measurements by the beta ray gage were found to conform more generally with physical weight profiles. Accordingly, Southland approached Tracerlab, Inc., with the problem of designing an instrument with specifications to fit their needs as follows: the instrument to give a recorded weight profile which has a scale of 1 in. in chart length equivalent to 1 ft. of the paper passing through the measuring area. A variable speed drive on the recorder to enable this scale to be changed if desired. The sensitivity in terms of basis weight variation to be sufficient to indicate a fluctuation of 0.2 lb. per 3000 sq. ft. The beta ray scanner to be sufficiently simple in operation, with a minimum of time consumption for sample measurement so that machine adjustments could be made within 15 min.

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THEORY AND INSTRUMENTATION

The beta ray scanner itself comprises one of the first major industrial uses of radio-isotopes. It operates on the principle that a sheet of material moving between a source of beta radiation and a radiation detector will absorb an amount of radiation proportional to the weight per unit area of the sheet.

Beta radiation, rather than x-rays or gamma radiation, is utilized for the following reasons:

1. A much weaker radiation is required.
2. Absorption of beta rays is primarily a function of weight

Fig. 1 Tracerlab beta ray scanner

per unit area. X-ray and gamma radiation absorption depend more upon the atomic number of the absorbing material.

3. The production and regulation of x-rays require complex electronic circuitry and extremely high voltage.

4. Beta radiation can be used to measure extremely thin materials not feasible with x-rays.

Also of importance is the fact that, with the radiation source open, there is a radiation of only 12.5 milliroent-

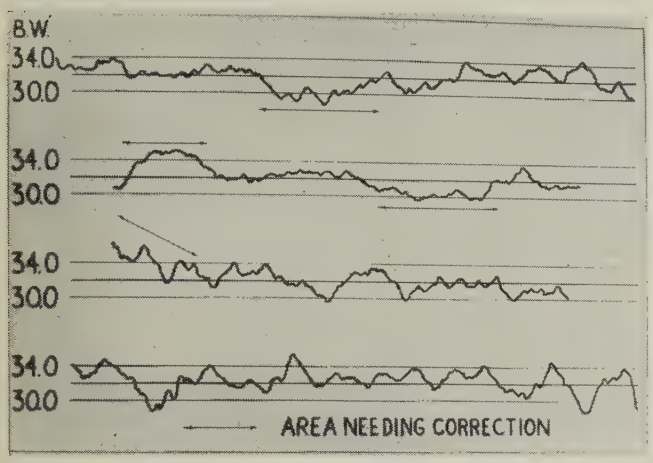

Fig. 2. Typical high speed newsprint from four manufacturers

gens per hr. at 18 in. Since the permissible radiation dosage rate is 500 milliroentgens per week, the scanner presents no hazard to operating personnel.

The requirements of the instrumentation necessary to complete the measuring system and to provide useful results are: (1) high accuracy of readings, (2) consistent reproducibility of readings, (3) durability of construction, and (4) ease of operation and maintenance. To satisfy these requirements, Tracerlab employed an electronic, strip-chart, recording potentiometer developed by the Brown Instruments Division of the Minneapolis-Honeywell Regulator Co.

Figure 1 shows the beta ray scanner as it is used in the laboratory. Across the front near the bottom are four knobs which are used in calibrating and zeroing of the instrument. Above these is the meter which indicates the weight on a scale which is divided into 40 divisions. The electronic strip chart recorder is on the sloping front, and it is graduated from 10 to 50 lb. per 3000 sq. ft. in terms of basis weight. The paper feeding mechanism consists of driven rollers on each side of the cabinet. The radioactive source is located on the top center of the cabinet directly under the detector head.

Calibration of the beta ray scanner was made using a cellophane which had a relatively even weight distribution. Sufficient sheets were inserted in the detection area to give the desired mass near the lower and upper ends of the desired basis weight range. The instrument is equipped with a weight control in order that materials of widely different masses may be brought on scale, and with a selector to adjust the magnitude of sensitivity at any given mass.

EXPERIMENTAL PROCEDURE

Samples are removed from the reels of newsprint by taking a strip about 18 in. wide across the machine. This strip is torn off and folded immediately to minimize moisture variations. The sample is cut to exactly 10 in. in width, weighed on a balance, and the length determined for use in calculating the basis weight, and, finally, is run through the beta ray scanner. Afterwards, the recorder chart is cut with a vibratool along the weight profile line, and the lower half is mounted on a strip of cylinder board. These profiles are placed for observation in a rack which holds 3 days' accumulation for that particular machine.

DISCUSSION OF RESULTS ON PAPER

Figure 2 depicts sheets needing correction by adjustments on the wet end of the machine. The heavy or light edge of the sheet probably can be corrected by slice adjustment. Light or heavy streaks in the paper are not always subject to correction. With poorly designed distribution systems, a slice adjustment in one position will cause a streak to recur in another position. The average basis weight is subject to correction, but the sawtooth pattern is not as it originates from the velocity pattern inside the headbox.

To determine the frequency of change in wave patterns, 10 profiles were made on strips of paper cut at equal distance within one revolution of the wire. The charts show that many of the wave patterns remained intact throughout. Following this, stub rolls were run to determine if a cyclic variation in machine direction would be apparent when several thousand feet of paper were run through the beta ray scanner. The results indicated no cyclic variation, but random variation of the weight above and below the average basis weight. These variations are attributed to the characteristics of the headbox and distribution system, with the possibility of other factors being involved.

Figure 3 shows the degree of average variation of basis weight from the average due to machine speed. The profiles from a large number of strips taken at 100-ft. intervals of speed from 1000 to 1400 f.p.m. were

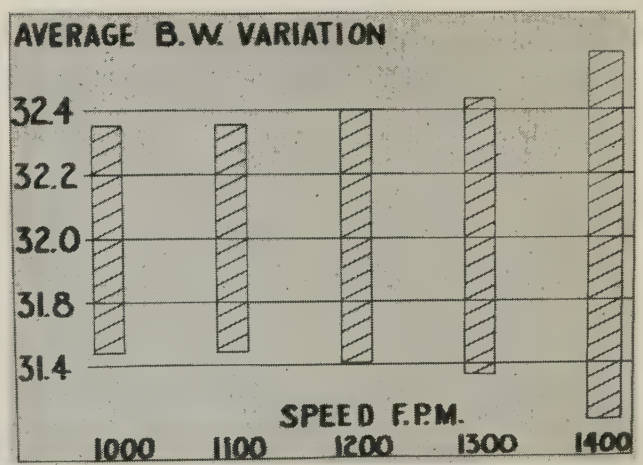

Fig. 3. Extent of average basis weight variation due to speed

planimetered to determine the average basis weight line and the area variation above and below the average line. The average of these areas was determined, converted to basis weight, and plotted against the speed. It is evident that machine speed alone is an important factor in governing weight profile when all other operating variables are left intact. As will be shown in a later figure, the average weight variation can be kept

at a minimum by proper design of the wet end for high speeds.

Figure 4 illustrates profiles of newsprint from machine showing a very level sheet, typical of low speed operation, and one with a very pronounced sawtooth pattern, typical of modern high speed operation. The rectangles marked on the profiles represent 12 by 18-in. sections which may be taken from the sheet to determine basis weights. It is quite evident that spot sampling from a roll of newsprint by customers can very easily give a false basis weight on present day operation, whereas this method was quite adequate in the past. Customers are finding by these spot samples extreme basis weight variations which were not justified by the averages. The same situation existed in the mill from taking rectangular samples. Presently, for the calculation of theoretical production, the basis weight is derived from full width machine strips.

Figure 5 illustrates the typical profiles of high-speed newsprint operation. Strips were submitted by a number of mills in the United States and Canada using both gravity and pressure headboxes. This study was made to facilitate our thinking in the choice of a headbox to replace one that had been in service for 13 years and was rusting out in the bottom. Pressure headboxes alone did not always deliver the ultimate in level sheets to the wire. On one rare occasion when the cross-flow distributor was used in the box in conjunction with all of the design recommendations of the manufacturer regarding stock and white water handling, the sheet looked very good. The manufacturer indicated that the wilder examples using pressure boxes, generally, could be accounted for by the absence of cross-flow distribution, improper white water collection, and/or improper new stock introduction. The proper handling of these items probably accounts, in part, for some of the good sheets delivered from gravity boxes. With all of this in mind, a Beloit pressure box with cross-flow distributor has been purchased, and the pre-box recommendations of stock and white water handling will be followed as nearly as possible.

The beta ray scanner has enabled the technical service department to have an independent check of operations performed by the machine crews. Basis weights are recorded and averaged for comparison with those turned in by machine crews. Observation of the previous day's weight profiles by supervisors enables a close check to see that light or heavy streaks have been eliminated as soon as they are detected. By the use of the profiles and the basis weights determined from the paper strips, paper qualities and machine efficiencies have improved generally. This work covered the period of May and June, 1953.

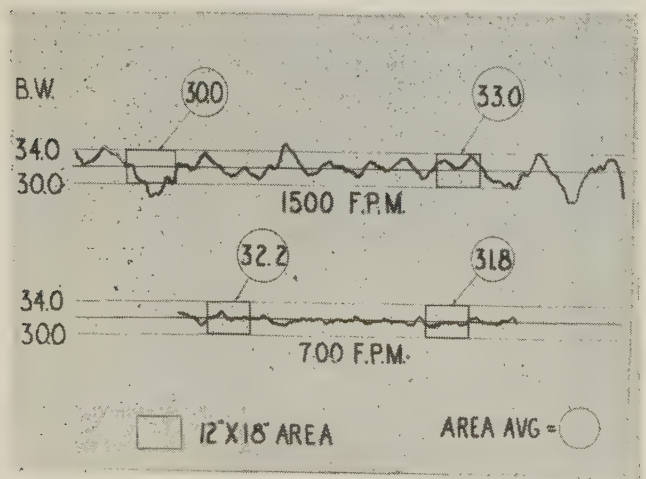

Fig. 4. Typical high and low speed newsprint operation with rectangles showing inequalities of template sampling

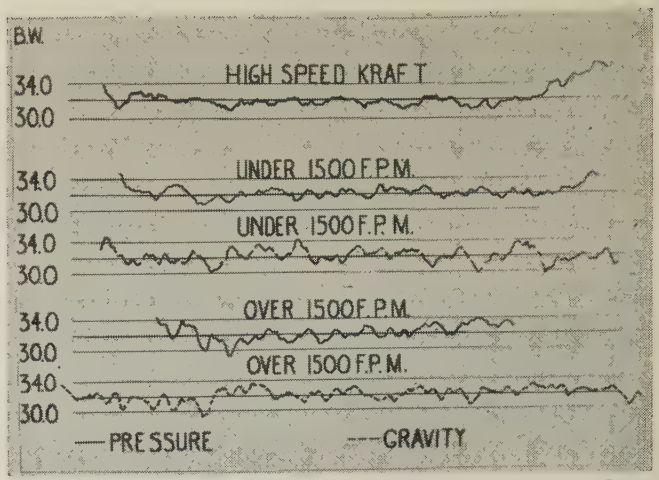

Fig. 5. Gravity and pressure headbox comparison above and below 1500 fpm

DISCUSSION OF RESULTS ON CLOTHING

Around the 1st of June, 1953, the idea was conceived to apply the beta ray scanner to wet felt measurement, after removal, to establish the wear pattern. One machine experienced short felt life due to excessive wear on the edges, and the other machine was experiencing considerable difficulty in building a hard reel in the center position. This reeling difficulty was possibly due to the first press felts wearing badly in the center, and the economics of felt life generally necessitated that some investigation be made to determine the amount and possible origin of these wear patterns. Elimination of these felt conditions should contribute to uniform moisture distribution across the width of the sheet when leaving the press section.

Figure 6 shows the felt profile from the first press of one machine along with the profile of a new felt sample submitted by F. C. Huyck & Sons. The "original crown" profile shows how badly the felt was worn in the center, and press roll crowning could be the most obvious source of this wear. After observing this felt condition throughout the life of several felts, it was decided to reduce the total crown on the two press rolls from 0.201 to 0.180 in. and prorate this total to the press rolls according to their diameters. The "corrected crown" profile shows that the amount of edge wear has been increased but it is not sufficient to cause trouble, whereas center wear has been reduced considerably. As yet, no attempt has been made to correlate plastometer and thickness of rubber covering on crown and felt wear. The "new felt" profile illustrates the fact that there will be some variation in the felt profiles due to manufacturing or due to method of feeding the felt through the beta ray scanner.

Figure 7 shows the edge condition which existed on the first press of the other machine. The ends of the granite press roll were relieved considerably starting at a point 2 ft. in from the ends, but the results have been inconclusive up to this date.

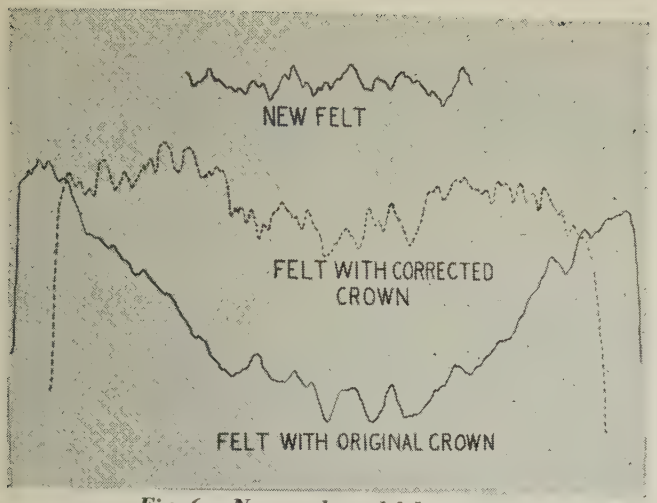

Fig. 6. New and used felt profiles

Previous to the conception of this method of measuring the weight profile of the used felts, it was necessary that felt samples be sent to the manufacturer where tensile tests were made to determine the wear pattern. With the beta ray scanner the results can be obtained in a few minutes after the felt is dry, whereas the tensile test method requires several weeks before the data are available. To determine the effects on the profile of fines, pitch, and dirt, tests have been made on the felts before and after cleaning. The results indicate that the same general profile will be achieved although the random heavy spots due to a large amount of filled up area will be eliminated.

With the felt work initiated and under control, it was decided about the 1st of July, 1953, to check the fourdrinier wires because of slack in the middle of one machine, which was felt to be instrumental in causing ridges to occur on startups and shutdowns.

Figure 8 shows the used wire profiles from both machines and a new wire. The sawtooth pattern in the used wires could be due to wear or bunching of the warp or shute wires during use. This weight change is on the order of magnitude of 1 wire per in., or 2% by weight. The fact that the saw tooth pattern exists in both the wire and paper profiles indicates that the random wet streaks cause more wear on these portions of the wire. The normal pattern of these used wires indicates 15% more wear in the center, which can be due to excessive crown in lumpbreaker roll or uneven flat box wear.

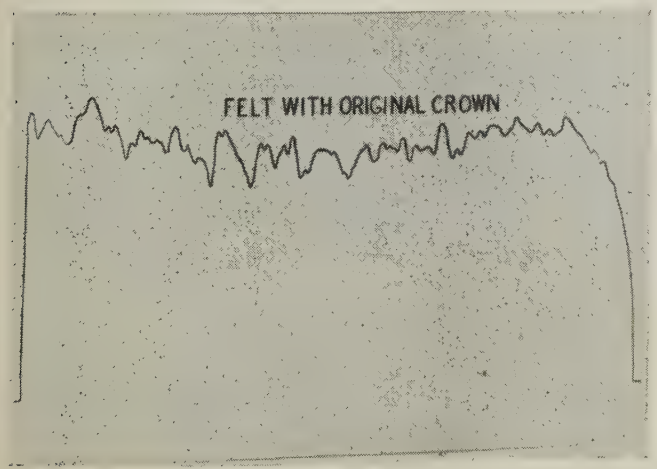

Fig. 7. Used felt profile

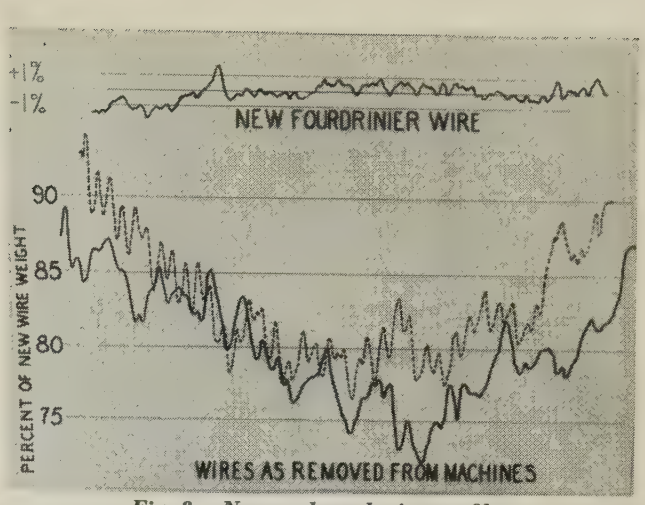

Fig. 8. New and used wire profiles

With this information on used wires, the next logical step was examination of strips of new wire. With open meshes passing through the measuring area it was desirable to know if accurate weight measurements were actually being recorded. Working with the Lindsay Wire Co., 236-in. strips of wire samples were submitted in 56 by 40, 56 by 42, and 56 by 44 mesh for profile measurement. It was found that accurate weight measurements were being made on meshed materials. Another strip was submitted which was removed adjacent to the seam of a wire which was finally used on one of the machines. The profile of a new wire in Fig. 8 shows some extremes of high and low points at one edge, and surprisingly enough, these and all other variations were present in exactly the same places on each of the three wires in the 40 through 44 series. These profiles could be superimposed one over the other with almost exact conformity of mass. This seems to indicate imperfections of some kind in the loom or weaving technique, but these imperfections in the wire are so slight that it is doubtful that they will ever influence improper sheet formation.

CONCLUSIONS

The beta ray scanner has been useful in improving the quality of Southland's newsprint and in making the proper choice in replacing some existing equipment. Profiles have been made on magazine paper before and after coating, and these afford excellent opportunity to examine the weight distribution of raw stock and coating. The beta ray scanner gives hope for more highly technical and advanced control procedure for reaching and maintaining sheet quality. It will enable papermakers to obtain improved clothing life on the machines, improve their machine efficiencies, and give an improved economic position. Presently, consideration is being given to the installation of a high-speed integrator to give an average basis weight for each strip.

It is the general opinion that this work has demonstrated some very interesting applications of the beta ray scanner to all textile, weaving, and solid sheet industries where profiles might play an important part in properly indicating true distribution of mass.

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Methods for Cellulose Accessibility Determination

GEOFFREY BROUGHTON, ROBERT E. HEEKS, and CONRAD JOHANNES

With the increasing importance of accessibility in pulp and paper technology it seems desirable for the Chemical Methods Committee of TAPPI to have available a suitable standard method for its determination. Accordingly the method so far used for the measurement of accessibility have been reviewed. Physical methods include x-ray diffraction, infrared absorption, density, water sorption, heat of wetting, and deuterium exchange measurements. Among chemical methods should be mentioned those depending on acid hydrolysis, oxidation, and esterification. It is concluded that for rapid, routine estimation of cellulose accessibility water vapor sorption should receive first study as a basis for a possible TAPPI standard method for determination of accessibility.

DURING the past few years many investigations of the accessibility of cellulose or its accessible to nonaccessible ratio have been made. The practical importance of this property has been recognized by the paper and pulp as well as the rayon and plastic industries (*1*, *47*, *67*). Such important properties as modulus of elasticity, tenacity, elongation to break, modulus of shear, and bending strength have been shown to be dependent on the degree of crystallinity (*38*, *47*).

According to Mark (*48*) "Crystallization plays an important role in that in building up a sample which is expected to have certain mechanical properties, the tendency of the material to crystallize as well as the tendency of the crystallites to be oriented, has to be taken into account." Several excellent reviews of the subject, e.g., Nickerson (*39*), Mark and Brill (*5*), Tarkow (*58*), and Timell (*60*) are available but no standard method for the determination of accessibility has been generally accepted. The x-ray diffraction method may be the most valid and theoretically sound; however, from the standpoint of equipment required, it is not practical for the ordinary laboratory. With the increasingly recognized importance of accessibility in pulp and paper technology, it seems desirable for the Chemical Methods Committee of TAPPI to have available a suitable mode of determination. Such a method should be reproducible, easy to perform and rapid, yet give results allowing pulps to be readily compared and ranked with respect to accessibility.

The purpose of this paper therefore is to review briefly the more promising methods so far proposed and to select one, on the grounds of reproducibility, speed and economy, as the most promising for experimental investigation as a possible TAPPI provisional standard.

The methods suggested divide themselves broadly into two types, physical and chemical. Physical methods usually show higher values for the accessible fraction (Table I) than do the latter.* They have the advantage of less danger of changes which might alter the crystallinity of the sample under test, occurring during the determination. Any strongly polar solvent or reagent which might allow reorientation of the crystallites must be regarded with suspicion. From this viewpoint even some physical methods may not be above reproach, although no chemical reaction occurs.

PHYSICAL METHODS

X-Ray Diffraction

Theoretically, because the specimen is untouched in any way and is unchanged at the end of the determination, this method is the least open to criticism. Basically it consists of measurement of the intensity of an x-ray beam before and after diffraction by the material. Figure 1 shows diagrammatically the apparatus used by Hermans and Weidinger (*28*). The primary beam of copper radiation I_0, monochromatized by reflection, is directed through a pinhole system P and allowed to strike the cellulose fiber pellet O. The intensity, I, of the beam of rays transmitted from O is then given by the relation:

$$I = I_0 e^{-\mu d}$$

where μ is the absorption coefficient of the cellulose and d the thickness of the pellet. The beam then strikes the front of an auxiliary miniature camera, G, where a disk of an inorganic comparison substance is located. The latter gives rise to a characteristic interference, I_c, on the film inside the miniature camera, which serves as a means for standardization of all exposure to equal intensity of the primary radiation, I_0. The intensity, I_l, of the beam transmitted from G follows:

$$\ln I - \ln I_l = \mu_1 d_1$$

where μ_1 and d_1 are the absorption coefficient and thickness, respectively, of the comparison preparation on G.

Figure 2 shows a complete photometer trace from which crystallinity is computed. In this I_c represents the comparison interference, the bottom hatched area the correction for incoherent radiation, the dotted line the correction for radiation scattered by air in the camera, and the upper hatched area the relative amount of the crystalline fraction. The relative measure, A_m, of the disordered fraction was found by subtracting the scattering due to thermal agitation, Compton radiation and air from the total background intensity, denoted by the line AB.

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* The concepts of accessible and nonaccessible cellulose have not been too well defined. These terms have been associated extensively with the words amorphous and crystalline. However, there is a difference, but usually small, between these two pairs of terms. The crystalline fraction has been defined as that which produces a sharp x-ray diffraction pattern, and the amorphous as that which produces only a diffuse background on the x-ray diagram. As opposed to this, the accessible fraction, particularly in the chemical methods of determination, is a measure of the vulnerability of the fibers to certain reagents. In this work the terms amorphous and crystalline are used only in reference to the x-ray method, while accessible and nonaccessible pertain to the results of other methods of determination.

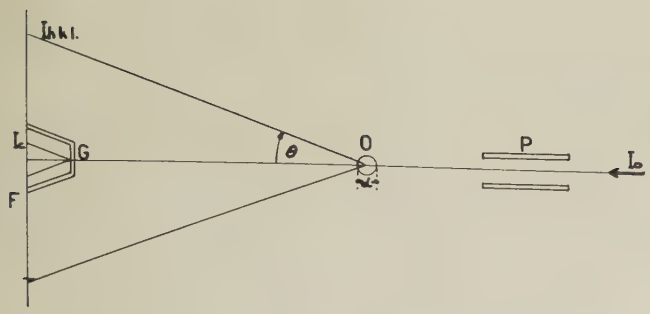

***Fig. 1. Diagram of apparatus for the x-ray method* (28)**

P = pinhole system. O = fiber pellet. F = film. I_c = comparison interference. I_{hkl} = cellulose spectrum. G = auxiliary miniature camera.

While the method has been used by several investigators (*24–27, 29, 31*) and yields results which perhaps should be considered as standards for the calibration of other methods, it has the disadvantage of not revealing extremely small crystallites and from the standpoint of equipment needed is unsuited for rapid, routine determinations.

Infrared Absorption

Measurements (*11*) made on crystalline and amorphous cellulose show that the conversion of crystalline regions into amorphous material results in a decrease in the sharpness and definition of the infrared spectrum of cellulose. Changes in the intensity of absorption at certain wavelengths were also found. This method still lacks precision, but even if it were to be refined further, like x-ray diffraction, it is not practical for our purposes except as an ultimate standard to which other test results might be referred.

Density

The density of cellulose fibers, as determined in a nonpenetrating medium, will depend on the percentage of crystalline matter in the sample (*22*). Two methods, the so-called flotation and varying temperature methods, have been used.

In the flotation method carefully dried cellulose filaments, 1 cm. long and 0.05 cm. thick, are placed in a flask filled with a mixture of carbon tetrachloride and nitrobenzene. Nitrobenzene from a microburet is then carefully added until the fibers remain suspended. A determination can be made in 10 min. once drying, which it is claimed requires 36 hr. *in vacuo* at 100°C., has been completed.

In the second modification a cellulose pellet is dried by displacement of the water by carbon tetrachloride vapor. After suspension of the pellet in dry liquid carbon tetrachloride, the temperature at which the pellet just sinks is noted, thus accurately measuring the cellulose density.

The higher the density, the greater the crystallinity, and it has been shown that density measurements rank a series of celluloses in the same order as x-ray or sorption measurements. While the range in density is small, 1.510 to 1.540, determinations can be precise and rapid, once drying has been effected. This method may hold promise for routine measurements.

Water Sorption

As a first approximation, the absorption of water vapor by cellulose fibers at a given relative humidity would be expected to increase as crystalline to amorphous ratio diminishes. While such a method is more open to criticism than the preceding because of changes which may be induced by swelling at high relative humidities, it does offer promise (*20, 30, 66*). The cellulose sample is dried either in an oven at 105°C. or over phosphorus pentoxide. The weighed dry sample is conditioned at 50 ± 1% R.H. and 75 ± 1°F. and reweighed. It has been shown (*62, 65*) that for a number of different celluloses the ratio of their water sorptions, measured at the same relative humidity, is substantially independent of relative humidity selected over a wide range. Since this is true, the test is not limited to the values taken at a single relative humidity except where very exacting work is required. More work should be done in this direction. However, Fig. 3 shows the relationship between moisture sorption (calculated on the basis of oven-dry weight) and accessibility according to Howsman (*30*) who calibrated the method by deuterium oxide exchange. The work had been confirmed by Tarkow (*58*). Substantially straight line relationships are obtained at 50 and 90% R.H. which is a good indication that one determination of regain at a given relative humidity is sufficient to fix accessibility if a calibration curve is available.

Another method of expressing results from moisture absorption data was given by Hailwood and Horrobin (*17*) who developed an equation for the adsorption isotherm. Some of the basic assumptions used in deriving this equation have been questioned (*58, 61*) although it has given accessibility values which are the same as those obtained by other physical methods (*20*).

The experimental procedure is similar to the preceding method with the exception that points must be taken at a number of different relative humidities to establish the constants in the equation. Once this is done, the nonaccessible fraction can be readily calculated.

Water sorption methods are reproducible, experimentally simple and, in particular, the first method described possesses all the advantages to be sought in a routine method, provided that a satisfactory calibration can be made which has universal application to all types of cellulose.

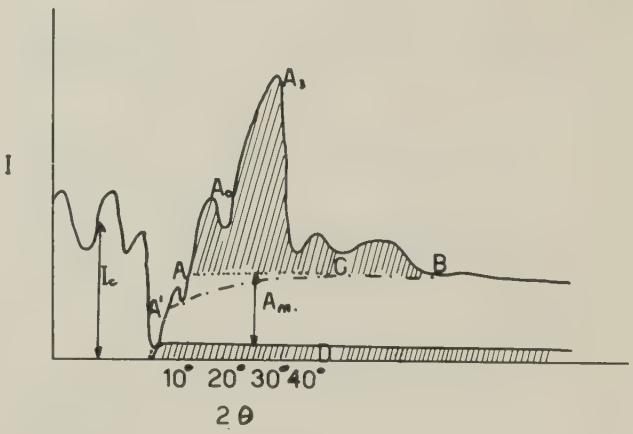

***Fig. 2. Complete photometer curve of native ramie* (28)**

I_c = comparison interference. ACB = background curve. Area ABA' = correction for air scattering. Area D = correction for thermal and compton effects. A_m = measure of disordered region.

Iodine Sorption

Sorption methods other than water have been used to give a measure of the accessible portion of a cellulose sample. Schwertassek, in particular, has worked extensively on the adsorption of iodine by cellulose (*53*, *54*, *55*). The amount of adsorbable iodine is measured by treating the fibers with a small amount of I_2-KI solution followed by titration of the unadsorbed iodine with $Na_2S_2O_3$. The calculated amount of iodine adsorbed then gives an indication of the accessible portion of the fibers.

Heat of Wetting

This has been defined as the heat evolved, expressed in calories per gram of dry material, when a sample is completely wetted at any given moisture regain. As already explained absorption of water by cellulose is considered to occur almost entirely in amorphous regions where there are accessible hydroxyl groups (*50*). It follows from this that the heat of wetting of a cellulose sample should be a measure of the amount of accessible material contained in the sample.

Heats of wetting have been determined by various workers (*8*, *21*, *32*, *36*). The usual procedure involves a series of determinations in a calorimeter while varying the moisture regain values of the samples. The ratio of the heats of wetting for any samples gives an indication of the relative amounts of accessible material contained in those samples.

One disadvantage of this method is the complex technique and apparatus required. Also heats of wetting of cellulose samples reported in the literature vary widely, although some are in good agreement.

Deuterium Exchange

This method is based on the difference in rate at which accessible and nonaccessible cellulose react with heavy water.

The experimental procedure (*13*, *14*, *51*) consists in drying a sample of cellulose with air to a water content of 6 to 13%. After weighing the sample into a tared reaction cell, a known amount of heavy water is added. To increase the reaction rate the mixture is stirred.

Samples of the heavy water-water mixture are withdrawn at intervals and microdistilled before determining their specific gravity.

Assuming (1) that the moisture present in the sample is very rapidly diluted by the heavy water and (2) that

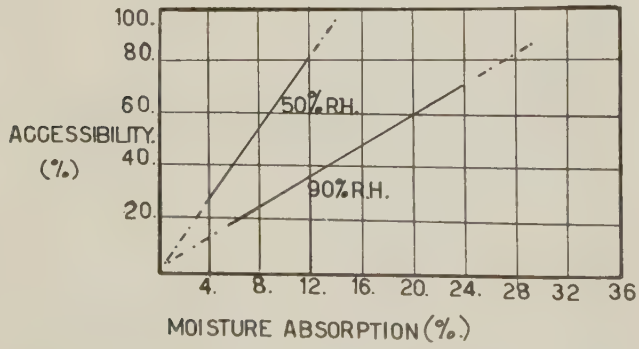

Fig. 3. Moisture absorption versus accessibility of cellulose **(53)**

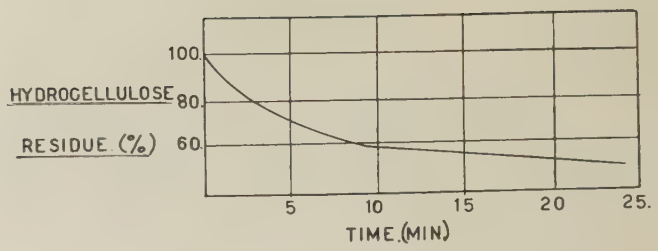

Fig. 4. Hydrolysis curve for regenerated cellulose **(3)**

all three cellulose hydroxyl groups are indistinguishable so far as rate of exchange is concerned, the fraction of cellulose hydroxyl groups which have exchanged deuterium for hydrogen may be calculated. It is found that this fraction is substantially constant after four hours. The relation between the amount of nonaccessible material and extent of reaction, F, is written (*14*):

$F' = \sigma\alpha + (100 - \alpha)$
$F' = 100F$ = per cent of all the hydroxyls which react rapidly with D_2O
σ = fraction of OH groups of crystalline regions which are in the surface and accessible to D_2O
α = per cent crystalline material in sample

Hence

$$\alpha = \left(\frac{100 - F'}{1 - \sigma}\right)$$

The value of σ was taken by Mark *et al.* (*14*) as 0.28. It follows that the method described above gives an empirical value for percentage accessibility. Further, since swelling may occur during the deuterium exchange, the method is not recommended for determinations where nonswelling is desirable.

CHEMICAL METHODS

These are all based upon the principle that the accessible regions in the cellulose should react more readily with reagents than the nonaccessible areas. Intrinsically such methods involve submission of the cellulose to powerful reagents, which may well affect the arrangement of crystallites and their surroundings thus leading to changes in the ratio which it is desired to determine.

Acid Hydrolysis

This has perhaps been the object of more work (*3*, *9*, *10*, *12*, *19*, *33–35*, *42–45*, *49*, *52*, *57*) than any other method for determining the accessible-nonaccessible ratio and there is still uncertainty on the exact nature of the reaction.

In a typical procedure a small sample (1 gram) of dry cellulose is hydrolyzed under definite conditions of acid concentration, volume, temperature, and time. As hydrolysis proceeds, undissolved residue weights are taken at definite time intervals and a plot is made of percentage hydrocellulose residue versus time (Fig. 4). The initial rapid hydrolysis diminishes rapidly until finally a straight line results. Extrapolation of this to zero time allows the relative amounts of resistant (nonaccessible) and nonresistant (accessible) materials to be estimated. A modification has been recently introduced by Schwabe and Frind (*56*) who, using H_2SO_4 as the hydrolyzing agent, determined the

amount of hydrolyzed cellulose rather than residue weights. This was done by oxidizing the filtrate with 0.25 *N* $K_2Cr_2O_7$ and H_2SO_4, then back-titrating the excess chromic acid.

This is without doubt an oversimplification because the percentage accessible material indicated by such procedures is much lower than that given by the x-ray diffraction method (Table I). The major cause of this is believed to be that crystallization and hydrolysis of the accessible material take place simultaneously (*3, 4, 12, 29, 30, 52, 63, 64*). Battista (*3*), comparing mild, drastic, and mild plus drastic hydrolysis conditions, found a much smaller loss in weight under mild than under drastic conditions. Somewhat surprisingly, the samples lost less weight when subjected to a standard drastic hydrolysis treatment after they had been exposed to a preliminary mild hydrolysis than they did when given the standard drastic treatment directly. The conclusion drawn was that under mild hydrolytic conditions crystallization and crystal growth could occur simultaneously with hydrolysis. Roseveare (*52*) suggested that partial oxidation of the amorphous regions prior to hydrolysis could inhibit crystallization to a large extent. It was not recommended because of the difficulties involved together with poor reproducibility of results. Recently, Meller (*34, 35*), treating acid hydrolysis from the kinetic viewpoint, obtained good agreement between the calculated and observed values for hydrolysis of cotton fibers at 80 and 100°C.

Although when properly controlled the method is capable of giving reproducible values and experimentally is not too difficult to perform, there are a number of adverse considerations. Other than crystallization during hydrolysis discussed above, problems arising in other chemical techniques are also present here. A few of these are: the surface layer of the crystallites is probably accessible (*40*), reagents may penetrate and attack the crystalline regions, the degree of swelling (*2, 18*) and the nature of the reagent and solvent used may have a determinative effect on the accessibilities measured (*23*). Until crystallization during hydrolysis can either be eliminated or accounted for, adaptation of this method over other chemical methods for a standard does not seem advisable. However, the potentialities of acid hydrolysis have been shown to be good from the viewpoints of simplicity and reproducibility of results, which encourages more work to be done on hydrolysis techniques.

Oxidation

The 2, 3-hydroxyl groups of the glucose units along the cellulose chains are readily attacked by oxidizing agents, the rate determining step being primarily the diffusion of oxidizing ions into the fiber. The oxidation can be plotted as a function of time, and because diffusion rates are slow in crystalline areas and relatively fast in amorphous material, the resulting curve extrapolated to zero times gives an indication of the accessible-nonaccessible ratio.

Periodic acid has been investigated as an oxidizing agent (*16, 41*), but promising results have also been obtained by Glegg (*15*) using chromium trioxide in an acetic acid-acetic anhydride solvent mixture. The standardized chromium trioxide and cellulose sample are agitated together and the concentration of chromium trioxide determined from time to time. Extrapolation to zero time of a plot of moles chromium trioxide reduced per glucose unit versus time, allows a measure of the accessible cellulose to be obtained. Glegg claims that the method is free from swelling effects and is reproducible to ±10%.

Chromium trioxide oxidation may be closer to the requirements for a standard method than the hydrolysis method but requires further investigation, particularly in aqueous solution.

Thallous Ethylate

This method is based on the reaction:

$$\text{Cellulose OH} + \text{TlOEt} \rightarrow \text{cellulose OTl} + \text{EtOH}$$

On heating with excess methyl iodide the resulting thallium cellulosate gives methyl cellulose and thallous iodide.

$$\text{Cellulose OTl} + \text{MeI} \rightarrow \text{cellulose OMe} + \text{TlI}$$

After purification the methoxyl content of the partly methylated cellulose can be determined and this accepted as proportional to the number of hydroxyl groups which reacted with the thallous ethylate. According to Assaf, Haas, and Purves (*2*) such reaction is restricted to the amorphous portion of the cellulose. Furthermore, if determinations are made in a series of solvents the accessibility value can be corrected to zero penetration or swelling in the crystalline portions of the fiber.

The precautions necessary with this method, the

Table I. Some Selected Accessible Values

Method	*Rayon*	*Wood pulp*	*Cotton*
Physical			
X-ray	60,[29, a, b] 55–60[5, a]	25–35,[5] 35[29, a]	35–40,[5, a] 31[30]
Density	60[5, a]	40–50,[5, a] 47,[30] 50[14, a]	30–40[5, a]
Deuterium exchange	50–60,[5, a] 66[14]	37,[5, a] 46[14]	18–25,[5, a] 21,[14] 30[30]
Semiphysical			
Water sorption	60,[5, a] 65[17]	35,[5] [a] 45[20]	32,[17] 30,[5, a] 37[20]
Heat of sorption	.....	.....	13[30]
Chemical			
Oxidation (HIO_4)			1–2,[14, c] 6[16]
Thallation	.....	.....	0.4[59]
Hydrolysis	27,[5, a] 25,[33] 18–30[52] 15–31.5[9]	7 8,[3, a] 10.5,[30] 10[9] 7–12,[52] 8–15[6]	5,[5, a] 8.5,[30] 6,[30] 5.9[33] 4.5,[33] 14,[49, a] 7[52]
Formylation	77[59]	6,[6] 35,[59] 47[59]	28[59]

[a] Some authors have presented their results in terms of crystallinity. To obtain consistency in this table, accessible material is approximated by taking 100 − the reported percentage crystalline material.
[b] The superscript figures refer to references in Literature Cited.
[c] Reported by the original author as percentage amorphous material.

time and methoxyl analyses involved appear to make it suitable only as a research tool. The results quoted by investigators (Table I) are very low compared to those given by the physical methods and some other chemical methods.

Formylation

This method utilizes the ability of formic acid, under specified conditions (e.g., 2 hr. at 30°C.), to esterify only the primary hydroxyl groups in poly-anhydroglucoses (*46*). Chain degradation cannot occur since formic acid is unable to break the glycosidic bonds in α-methyl glucoside. It follows that recrystallization cannot occur as in the acid hydrolysis method.

The method, as suggested by Nickerson (*46*) and used by one of the authors (*6*) consists in weighing the sample of cellulose, followed by soaking it in anhydrous formic acid for a given length of time at a controlled temperature. The fibers are then filtered, washed until free from acid, and placed in a known volume of standardized alcoholic potash. After refluxing to complete saponification, the excess alkali is back titrated and the combined formic acid per anhydroglucose unit calculated. Assuming white dextrin to be completely accessible (since it is soluble) when formylated under similar conditions,

$$\% \text{ accessible cellulose} = \frac{100(\text{combined formic acid in cellulose sample})}{\text{combined formic acid in white dextrin}}$$

Tarkow and Stamm (*59*) have suggested a different method of carrying out the reaction, which leads to considerably higher accessibility values than those given by the method outlined above (*59*) (Table I). Although formylation has given results in accord with physical methods, it has been shown by Browning and Sell (*7*) that this reaction is not necessarily specific to the primary hydroxyl groups. Therefore, this method seems less promising than it first appeared.

CONCLUSIONS

With the desiderata of rapidity, accuracy, reproducibility, and simplicity of experimental procedure all in mind, the methods which appear particularly promising for accessibility determination are water vapor sorption, density determination, and, among chemical methods, acid hydrolysis and oxidation. It is suggested that these be considered and investigated as possible provisional TAPPI Standards for accessibility determination.

LITERATURE CITED

1. Alfrey, T., "Mechanical Behavior of High Polymers," Interscience Publishers, Inc., New York, 1948.
2. Assaf, A. F., Haas, R. H., and Purves *J.A.C.S.* 66: 59 (1944).
3. Battista, O. A., *Ind. Eng. Chem.* 42: 502 (1950).
4. Brenner, F. C., Frilette V., and Mark, H. *J.A.C.S.* 70: 877 (1948).
5. Brill, R., and Mark, H., *Z. Electrochem.* 55: 202 (1951).
6. Broughton, G., *Paper Trade J.* (Jan. 4, 1951).
7. Browning, B. L., and Sell, L. D., *Text. Res. J.* 63: 939 (1953).
8. Chilikin, M. M., *Zhur. Priklad Khim.* 3: 221 (1930).
9. Conrad, C., and Scroggie, A. G., *Ind. Eng. Chem.* 37: 592 (1945).
10. Davidson, S. F., *J. Text. Inst.* 32: T132 (1941).
11. Forziati, F. H., and Bowen, J. W., *J. Res. Natl. Bur. St.* 46: 38–42 (1951).
12. Foster, D. H., and Wardrop, A. B., *Aust. J. Sci. Res.* 4: 413 (1951).
13. Frilette, V. J., Hanle, J., and Mark, H., *Anal. Chem.* 19: 984 (1948).
14. Frilette, V. J., Hanle, J., and Mark, H., *J.A.C.S.* 70: 1107 (1948).
15. Glegg, R. E., *Text. Res. J.* 21: 143–148 (1951).
16. Goldfinger, G., Mark, H., and Siggia, S., *Ind. Eng. Chem.* 35: 1083 (1943).
17. Hailwood, A. J., and Horrobin, S., *Trans. Far. Soc.* 42B: 84 (1946).
18. Harris, C. A., and Purves, C. B., *Paper Trade J.* 110: 29 (1940).
19. Harris, E. E., and Lang, B. G., *J. Phys. Colloidal Chem.* 51: 1430 (1947).
20. Heath, M., and Johnson, M., *Tappi* 33: 386 (1950).
21. Hermans, P. H., "Contribution to the Physics of Cellulose Fibers," Elsevier Publishing Co., 1946, p. 33.
22. Hermans, P. H., "Physics and Chemistry of Cellulose Fibers," Elsevier Publishing Co., 1949, p. 200.
23. Hermans, P. H., *J. Chim. Phys.* 44: 135 (1947).
24. Hermans, P. H., *J. Polymer Sci.* 5: 565 (1950).
25. Hermans, P. H., *Kolloid Z.* 115: 103–109 (1949).
26. Hermans, P. H., *Kolloid Z.* 128: 3–9 (1951).
27. Hermans, P. H., *Makromol. Chem.* 6: 25–29 (1951).
28. Hermans, P. H., and Weidinger, A., *J. Appl. Phys.* 19: 491 (1948).
29. Hermans, P. H., and Weidinger, A., *J. Polymer Sci.* 4: 135 (1949).
30. Howsman, J., *J. Text. Res.* 19: 152 (1949).
31. Kast, W., and Flaschner, L., *Kolloid Z.* 111: 132 (1948).
32. Lauer, K., Döderlein, R., Jäckel, C., and Wilde, O., *J. Makromol.* 76 (1943).
33. Lovell, E. L., and Goldschmid, O., *Ind. Eng. Chem.* 38: 811–817 (1946).
34. Meller, A., *J. Polymer Sci.* 4: 619 (1949).
35. Meller, A., *J. Polymer Sci.* 10: 213 (1953).
36. Morrison, J. L., Campbell, W. B., and Maass, O., *Can. J. Res.* 18B: 168 (1940).
37. Nelson, M. L., and Conrad C., *Text Res. J.* 18: 149 (1948).
38. Nickerson, R. F., "Advances in Carbohydrate Chemistry," Acad. Press Inc. New York, Vol. 5, 1950, p. 126.
39. *Ibid.*, p. 103.
40. *Ibid.*, p. 120.
41. *Ibid.*, p. 122.
42. Nickerson, R. F., *Ind. Eng. Chem.* (*Anal. Ed.*) 13: 423–426 (1941).
43. Nickerson, R. F., *Ind. Eng. Chem.* (*Anal. Ed.*) 34: 85–88 (1942).
44. Nickerson, R. F., and Habrle, J. A., *Ind. Eng. Chem.* 38: 229–301 (1946).
45. Nickerson, R. F., and Habrle, J. A., *Ind. Eng. Chem.* 39: 1507–1512 (1947).
46. Nickerson, R. F., *Text. Res. J.* 21: 195 (1951).
47. Ott, E., "Cellulose and Cellulose Derivatives," Interscience Publishers, Inc., New York, 1946.
48. *Ibid.*, p. 1014.
49. Phillip, H. J., Nelson, M. L., and Zifle, H. M., *Text. Res. J.* 17: 585 (1947).
50. Rees, H. W., *J. Text. Inst.* 39: T35 (1948).
51. Rittenberg, D., Keston, A. S., and Schoenheimer, R., *J. Biol. Chem.* 122: 227 (1937).
52. Roseveare, W. E., *Ind. Eng. Chem.* 44: 168 (1952).
53. Schwertassek, K., *Faserforsch u. Textiltech.* 3: 87–95 (1953).
54. Schwertassek, K., *Melliand Textilber.* 32: 460–465 (1951)
55. Schwertassek, K., *Melliand Textilber.* 31: 764–769 (1950).
56. Schwabe, K., and Frind, H., *Faserforsch u. Textiltech.* 4: 91–99 (1953).
57. Saeman, J. F., *Ind. Eng. Chem.* 37: 43 (1945).
58. Tarkow, H., *Tappi*, 33: 598 (1950).
59. Tarkow, H., and Stamm, A. J., *J. Phys. Chem.* 56: 266 (1952).
60. Timell, F., "Studies on Cellulose Reactions," Esselte Aktiebolag, Stockholm, 1950.
61. *Trans. Far. Soc.*, General Discussion on Swelling and Shrinking, 42B, 93–102 (1946).
62. Urguhert, J., *J. Text. Inst.* 16: T155 (1925).
63. Weller, R. C., Boss, K. C., and Roseveare, W. E., *Ind. Eng. Chem.* 40: 138 (1938).
64. Ward, K., Jr., *Text. Res. J.* 20: 363 (1950).
65. Wiegerink, J., *Text. Res. J.* 10: 357 (1940).
66. Wink, W. A., *Ind. Eng. Chem.* (*Anal. Ed.*) 18: 251 (1946).
67. Yurugi, T., and Furnya, J., *J. Soc. Text. Cellulose Ind.* 6: 87 (1950).

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Relationship of Tire Cord Properties to the Amount of Beta-Cellulose and Resistant Pentosan in the Pulp

D. D. BACHLOTT, I. K. MILLER, and W. D. WHITE

A comparison of pulp characteristics with properties of rayon tire cord made from the pulp indicates that cord strength and fatigue resistance increase as the beta-cellulose content decreases. Tire cords made from pre-hydrolysis-sulphate pine pulp increase in fatigue resistance with decreasing amounts of resistant pentosan. Measurement of pulp solubility in 10 and 18% NaOH solution as a substitute for the determination of alpha, beta, and gamma-cellulose is discussed.

It has been known for a good many years that the character of the cellulosic raw material used in the viscose process has an appreciable effect on the quality of the rayon produced from it. This is particularly true in regard to high tenacity yarns used to reinforce automobile tires and other rubber products. In these high tenacity yarns, cotton linters pulps have proved superior to wood pulps. For instance, a comparison of the properties of tire cord made from a 95% alpha, commercial, rayon-grade sulphite wood pulp, of the type which has been widely used in the production of conventional textile rayon, with those prepared using cotton linters shows the cord from wood pulp to be inferior to the cotton linters cord by 0.1 to 0.15 g.p.d. in strength. In addition, the cord from this type of wood pulp is deficient in fatigue resistance. In tire cord this means the resistance to strength loss caused largely by the extension and compression to which the cord is subjected when the tire is run. Fatigue resistance is, however, among many factors, a function of the transverse properties of the yarn and therefore a high level of fatigue resistance in the cord usually indicates a yarn which will perform well in any use which requires good transverse properties. Cord made from conventional sulphite wood pulp is deficient in this respect having only about one-half the fatigue resistance of cord from cotton linters pulp.

However, in spite of the superiority of the linters pulp in cord properties, the use of wood pulp is desirable because of its more stable and lower average price and greater ease of processing into viscose. For this reason, a cooperative program has been carried on by this laboratory with a number of pulp companies to assist them in improving the quality of wood pulp for high tenacity rayon production.

EXPERIMENTAL

During the past several years a considerable number of experimental pulps have been evaluated for use in high tenacity rayon yarn processes. The majority of these pulps have been produced by the sulphate process with prehydrolysis. However, a few sulphite pulps have also been evaluated. In addition, several commercial pulps have been tested. In these evaluations, the pulps were processed into viscose on a small scale and the viscose spun into high tenacity yarn. The yarn was subsequently twisted into cord and the physical properties of both the yarn and cord determined. The pulps were also subjected to laboratory analysis. Thus, having data on a large number of pulps which were tested under closely comparable conditions, it was possible to establish certain correlations between pulp characteristics which could be measured in the laboratory and properties of the yarn and cord produced from the pulp.

The laboratory tests included determination of alpha, beta, and gamma-cellulose, solubility in 10% KOH, ether-soluble material, metallic impurities, aldehyde and carboxyl groups, rate of hydrolysis in dilute acid, total pentosan and the pentosan content of the alpha-cellulose which will be referred to as resistant pentosan. Alpha, beta, gamma-cellulose were determined by a method which is similar to the standard TAPPI method except that 18.0% NaOH solution was used instead of 17.5% solution as required by the TAPPI method. The standard TAPPI method for pentosan determination was used in this work.

In addition to the above tests, the solubilities of a number of pulps in 10 and 18% NaOH solutions were determined using the standard method of the Central Laboratory of the Swedish cellulose industry (*1*).

In determining the fatigue resistance of cords, the dynamically balanced or DB fatigue tester developed by Waller and Roseveare (*2*) was used.

RESULTS AND DISCUSSION

Relationship of Beta-Cellulose to Tire Cord Strength

Examination of the data obtained in this program reveals that the beta-cellulose content of the pulp is a good indicator of the strength and fatigue resistance to be expected from a tire cord produced from it. Figure 1 shows the relationship between the amount of beta-cellulose in the pulp and the strength of the tire cord made from the pulp. Among the pulps shown are pulps made by both the sulphite and prehydrolysis-sulphate processes from a variety of wood sources. This indicates that from the standpoint of strength a low beta pulp is desirable regardless of the process or the source of the cellulose. It might be well to point out that conditioned cord tenacity has been used in establishing this correlation rather than yarn tenacity or cord oven-dry tenacity because it appears to be less affected by minor variations in process which are unavoidable, particularly in small scale testing such as this.

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Effect of Pulp Characteristics on Fatigue Resistance

In the case of fatigue resistance, the relationship to pulp characteristics does not appear as simple as with cord strength. Both the pulping process and the source of the cellulose seem to have some bearing on this matter.

Prehydrolysis-Sulphate Pulp from Pine. Early work with prehydrolyzed sulphate pulp from pine indicated some relationship between the beta-cellulose content of the pulp and fatigue resistance. However, it was impossible to obtain a clear-cut correlation and it was apparent that there were additional factors affecting fatigue resistance. Interest in the resistant pentosan content of the pulp arose from reports in the literature (*3*) which indicated that holocellulose or pulp might contain fragments which are insoluble in cuprammonium hydroxide solution, and that these fragments contained appreciable amounts of pentosan. It was felt that if such material remained in the pulp, it might be resistant to reaction with the steeping caustic and, thus, not be well dispersed in the viscose and consequently might have an adverse effect on yarn and cord properties. One test which has been used as an indication of such material in a wood pulp is the determination of resistant pentosan (*4*) or the pentosan remaining after extraction of the pulp with caustic solution. This is essentially the same as determining the pentosan content of the alpha-fraction of the pulp. Consequently, the latter procedure was used in determining the effect of resistant pentosan on cord properties.

Figure 2 shows the relationship between the beta-cellulose content of the pulp and DB fatigue values after correcting the fatigue values for the effect of resistant pentosan. In this case the fatigue level was found to be proportional to the logarithm of the beta-cellulose content. The correlation is fairly good, especially when the experimental errors involved in both the pulp analysis and the establishment of the fatigue values are considered. The correction for resistant pentosan was determined by first comparing two samples with essentially the same beta-cellulose content but different resistant pentosan contents. This gave an approximate correction which was used to plot a curve of beta-cellulose versus corrected DB fatigue. Using this curve, it was then possible to correct the observed DB fatigue for beta-cellulose. In this case the fatigue values were corrected to 1.5% beta-cellulose since a zero level seemed rather unrealistic. The corrected fatigue values were then plotted against resistant pentosan and an average correction for resistant pentosan obtained from the

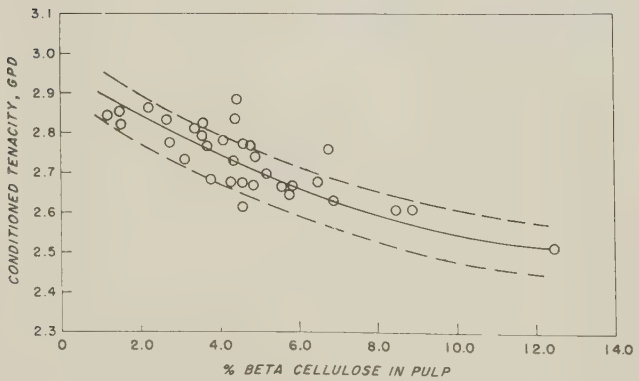

Fig. 1. Relationship of beta-cellulose to tire cord strength

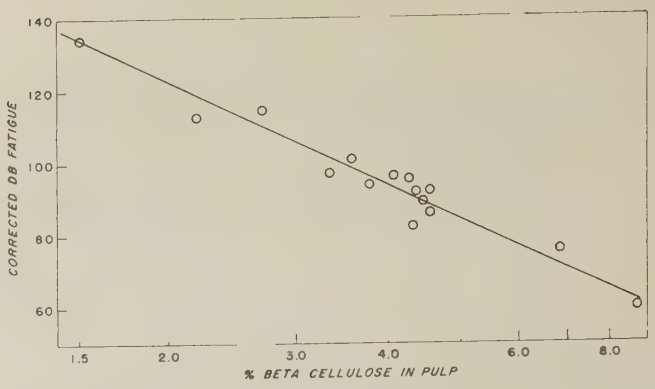

Fig. 2. Relationship of beta-cellulose to cord fatigue resistance—prehydrolysis-sulphate pulp from pine

slope of the curve. This average value was then used to plot the curve shown in Fig. 2. Figure 3 shows DB fatigue values corrected to a 1.5% beta-cellulose level plotted against resistant pentosan. Again the correlation is fairly good.

Prehydrolysis-Sulphate Pulp from Gumwood. Figure 4 shows the relationship between the beta cellulose content of the pulp and DB fatigue values for prehydrolysis-sulphate pulps from gumwood. With the exception of one sample, these pulps fall on a straight line. It is noteworthy, however, that the pulps which have the same beta-cellulose content as cotton linters give a somewhat lower fatigue level than cotton linters. In the case of these pulps, the resistant pentosan content appears to have little effect. Table I shows DB fatigue values corrected to a level of 1.5% beta-cellulose together with the corresponding resistant pentosan values. The corrected fatigue level remains relatively constant although the resistant pentosan varies considerably.

Sulphite Pulps. Data obtained on pulps made by the sulphite process indicate that, as in the case of prehydrolysis-sulphate pulp from gumwood, the fatigue resistance of tire cord is related to the beta-cellulose content of the pulp but not to the resistant pentosan content.

Figure 5 shows the correlation between beta-cellulose and DB fatigue values obtained with sulphite pulps. Pulps from different woods are included in this correlation. The fatigue ratings are not corrected for resistant pentosan. As shown in Fig. 6, the resistant pentosan content of the pulp has little, if any, effect on the fatigue level.

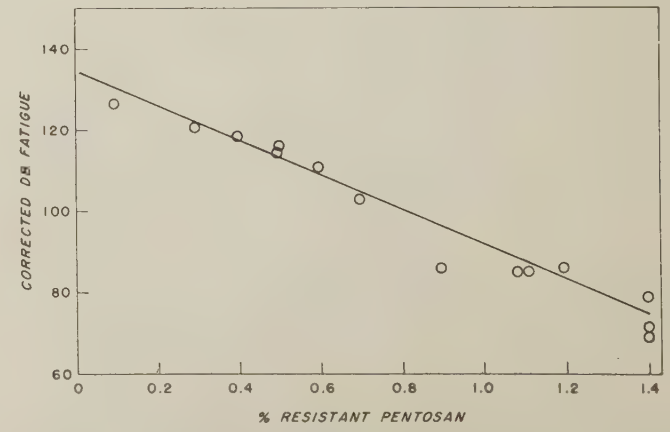

Fig. 3. Relationship of resistant pentosan to cord fatigue resistance—prehydrolysis-sulphate pulp from pine

Table I. Effect of Resistant Pentosan on Fatigue-Gumwood Pulps

Resistant pentosan, %	*DB fatigue corr. to 1.5% beta*
0.20	93
0.20	89
0.24	93
0.30	96
0.30	94
0.41	99
0.50	96
0.66	113
0.70	92
1.06	88
2.25	86

Solubility in Sodium Hydroxide as a Measure of Pulp Quality

From the foregoing, it is apparent that there is a fairly good general correlation between the beta-cellulose content of the pulp and cord tenacity and fatigue resistance. Unfortunately, beta-cellulose is an empirically determined characteristic. The reproducibility of the measurement is generally poor, especially between different laboratories. This is not surprising in consideration of the fact that in making the measurement, the pulp is first treated with 18% NaOH which is subsequently diluted to 9% and the undissolved material then filtered off without allowing sufficient time for equilibrium to be established. Thus, the amount of material dissolved represents neither the portion of the pulp soluble in 18% NaOH nor that soluble in 9% NaOH, but something in between. It would appear much more logical to determine the solubility in 18% NaOH and the solubility in 10% NaOH. The 18% solubility would give some indication of the yield which might be expected in viscose rayon production. The difference between the amounts of 10 and 18% soluble material would approximate or at least include that fraction of the beta-cellulose which remains after commercial steeping. This idea of using 10 and 18% NaOH solubility is not new. It was discussed in a paper by Wilson (*5*) in 1952. In this paper, it was concluded that if the beta-cellulose content is considered to have any effect on rayon quality, then the difference between the pulp solubility in 10 and 18% NaOH must be a better measure of pulp quality than the alpha-cellulose values which are currently considered important. Bartunek (*6*) has also indicated that such measurements may be of value.

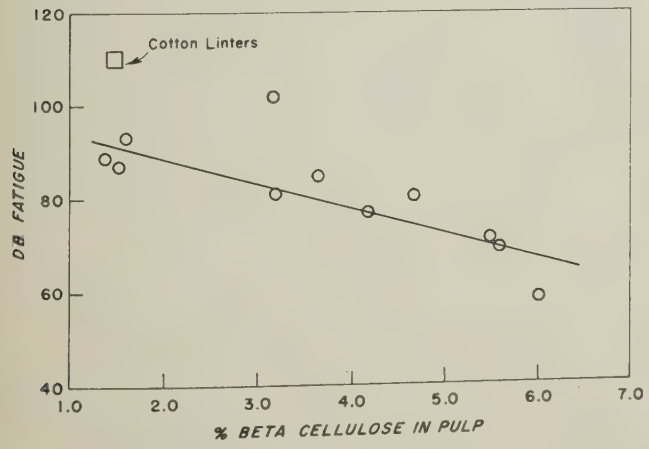

Fig. 4. Relationship of beta-cellulose to cord fatigue resistance—prehydrolysis-sulphate pulp from gumwood

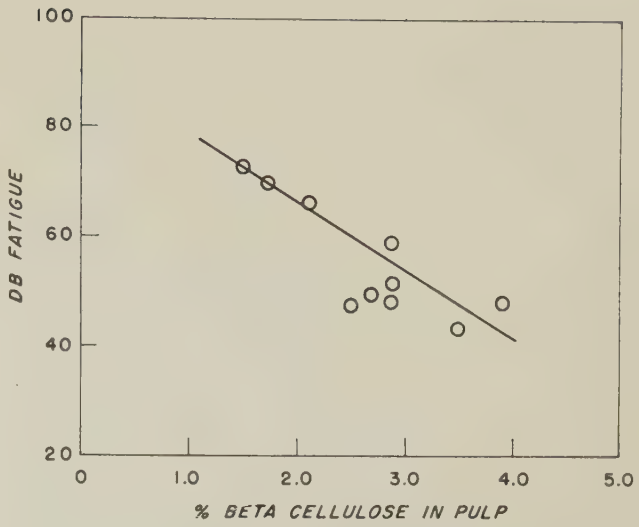

Fig. 5. Relationship of beta-cellulose to cord fatigue resistance—sulphite pulps

Results of a few tests which were made to determine whether or not the 10 minus 18% pulp solubility would correlate with cord tenacity are shown in Fig. 7. The correlation is about as good as that obtained with beta-cellulose. No attempt was made to correlate these values with fatigue resistance since the pulps tested include both gumwood and pine pulps and there are not enough of either to arrive at a firm conclusion on an individual basis. These data indicate that solubility measurements of this type, as applied to dissolving pulps, are at least as good a criterion of pulp quality as the conventional alpha, beta, and gamma values. These solubility measurements appear to be more logical and inherently capable of greater reproducibility than the alpha, beta, and gamma-measurement.

In a recent publication (*7*), Charles has shown that the yield of rayon to be expected from a pulp can be accurately predicted from the solubility in 21.5% NaOH solution. This suggests that determination of pulp solubility in 21.5 and 10% solutions might be the best approach.

CONCLUSIONS

In general, it can be said that the strength and fatigue resistance of tire cords increase as the beta-cellulose content of the pulp decreases. It must be recognized,

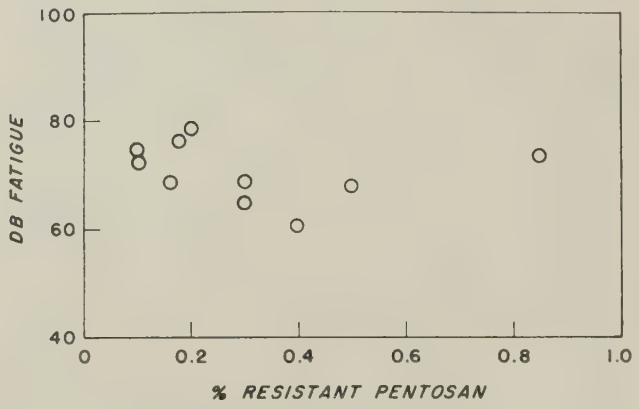

Fig. 6. Relationship of resistant pentosan to cord fatigue resistance—sulphite pulps

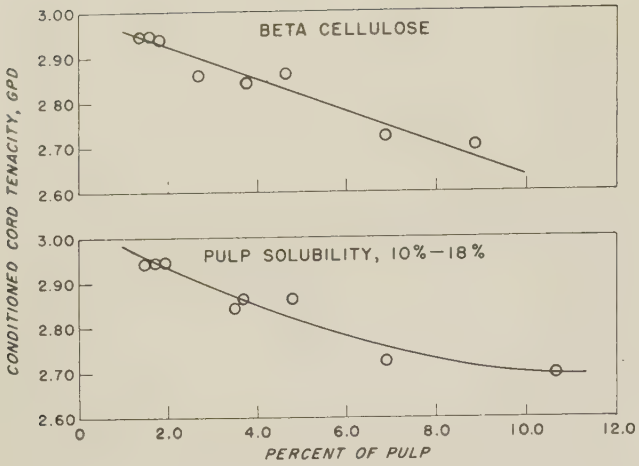

Fig. 7. Comparison of sodium hydroxide solubility with beta-cellulose as a measure of pulp quality.

however, that a given level of beta-cellulose may be arrived at by a number of processing routes and this characteristic can hardly be an infallible indicator of pulp quality.

In the case of prehydrolyzed sulphate pulp from pine, fatigue resistance of tire cords increases with decreasing amounts of resistant pentosan in the pulp.

Direct measurement of pulp solubility in 10 and 18% NaOH solution may provide a better characterization of dissolving pulp than the customary measurement of alpha, beta, and gamma-cellulose.

LITERATURE CITED

1. Method of the Analysis Committee of the Central Laboratory of the Cellulose Industry, CCA-8, *Svensk. Papperstidn.*, 47: 190–194 (1944).
2. Waller, R. C., and Roseveare, W. E., *J. Applied Phys.*, 17: 482–491 (1946).
3. Wardrop, A. B., and Dadswell, H. E., *Australian Pulp and Paper Ind. Tech. Assoc. Proc.*, 198–221 (1950).
4. Meller, A., *Paper Trade J.*, 124: 104–114 (1947).
5. Wilson, K., Ringstrom, E., and Hedlund, I., *Svensk. Papperstidn.*, 55: 31–37 (1952).
6. Bartunek, R., *Das Papier*, 6: 120–122 (1952).
7. Charles, F. R., *Tappi*, 37: 148–156 (1954).

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The assistance of C. W. Wilson, Mrs. K. C. O'Bier, and Miss C. A. Hale in carrying out the analytical work and of J. H. Waters in processing and spinning the pulps is gratefully acknowledged.

DISCUSSION

Frank R. Charles (Industrial Cellulose Research Ltd.). With regard to Mr. Bachlott's very interesting paper on the "Relationship of Tire Cord Properties to the Amount of Beta-Cellulose and Resistant Pentosan in the Pulp," we would like to add the results of investigations made in our pilot plants which show that caution should be observed in applying the beta-cellulose content of pulp as a yardstick for measuring tire cord quality, because conclusions might be misleading, or even diametrically opposed to the facts.

In the first place, the beta-cellulose content should be corrected for the degree of polymerization of the pulp because, as is well known, alpha-cellulose converts to beta-cellulose during depolymerization. Therefore, the important criterion regarding tire yarn quality should be the amount of beta-cellulose present, not in the original pulp, but in the aged alkali cellulose; this being of particular importance when comparing celluloses of low and high degree of polymerization because the latter have, of necessity, to be more depolymerized in the alkali cellulose aging to obtain viscose viscosities in the range required by the spinning process.

It was shown in my paper delivered before the February 1954 meeting (*Tappi* 37, No. 4: 148–156 (1954)) that beta-cellulose is approximately linearly related with degree of polymerization or intrinsic viscosity, the slope of the curve increasing with decreasing yield level of the pulp. The increase of beta-cellulose for tire yarn grade pulps (yield—97%) averages about 0.5% (on moisture free pulp) for each unit decrease of C.E.D. intrinsic viscosity. (It averages about 0.25% for linters grade pulps, yield level—99% and about 0.8% for regular viscose pulps, yield level—95%.)

In the second place, a particular series of pulps has been investigated in which the level of beta-cellulose even after correction for degree of polymerization, still varied in the opposite direction to the tire cord quality.

The following examples illustrate the above points:

Example 1. Comparison of a Very High Viscosity Sulphite Tire Yarn Grade Pulp with a Low Viscosity Prehydrolysis Sulphate Tire Yarn Grade Pulp

The following tire cord properties were determined under strictly controlled comparable conditions.

Resistant pentosan was essentially equal for the two pulps.

If the beta-cellulose values for the original pulps were taken as characterizing the tire cord value, then pulp A would be expected to be considerably superior to pulp B. However, comparison of the beta-cellulose at a common viscosity level (3.5 intrinsic viscosity arbitrarily chosen) shows the pulps really to be similar in beta-content in agreement with the tire cord properties.

	D.P.	Intrinsic (C.E.D.)	Beta-cellulose	Beta-cellulose corrected to 3.5 intrinsic viscosity[a]	Tire cord properties: Oven dry, g./den.	Tire cord properties: Conditioned g./den.	Tire cord properties: D.B. fatigue, min.
Pulp A							
A high viscosity sulphite pulp, tire yarn grade (UN 1474)	1420	9.1	1.4	4.2	3.25	2.82	107
Pulp B							
A low viscosity prehydrolyzed sulphate pulp, tire yarn grade (N 1007)	550	3.5	3.7	3.7	3.28	2.84	118

[a] Assuming 0.5 increase of per cent beta-cellulose per unit decrease of intrinsic viscosity.

	D.P.	Intrinsic viscosity (C.E.D.)	Beta-cellulose	Beta-cellulose corrected to 2.8 intrinsic viscosity[a]	Tire cord properties: Oven Dry, g./den.	Tire cord properties: Conditioned, g./den.	Tire cord properties: D.B. fatigue, min.
Pulp C (M-178)	970	6.2	2.3	4.0	3.28	2.81	88
Pulp D (M-175)	670	4.3	3.3	4.1	3.39	2.88	139
Pulp E (M-176)	500	3.2	5.2	5.4	3.34	2.89	135
Pulp F (M-179)	440	2.8	5.2	5.2	3.31	2.91	153

[a] Assuming 0.5 increase of per cent beta-cellulose per unit decrease of intrinsic viscosity.

Example 2. Results on Bleaching Down a Gumwood Prehydrolysis-Sulphate Tire Yarn Grade Pulp

A prehydrolyzed gum sulphate tire yarn pulp of intrinsic viscosity 6.2 was carefully bleached down to give three pulps of lower intrinsic viscosity, respectively 4.3, 3.2 and 2.8. The four pulps were processed into tire cord under strictly comparable conditions with the above results.

Gamma-cellulose was practically unchanged at *ca* 1.1%, and resistant pentosan was not decreased.

Beta-cellulose increased considerably in this series as the viscosity was lowered, and yet the tire cord properties actually improved. Even when the beta-cellulose values are corrected to a common viscosity level, they are still slightly in the opposite direction to the tire cord properties.

The above is not an isolated case; similar instances have been found with prehydrolysis-sulphate pulps to support the above results.

Use of the more recent concept of beta-cellulose as the difference between 18 and 10% NaOH solubility does not alter the above conclusions. The new beta value is still subject to a correction for degree of polymerization of approximately the same magnitude.

Determinations on the aged alkali cellulose are, of course, to be preferred to determinations on the original pulp because use of an artificial correction is avoided. In this connection, rather than determining beta-cellulose in aged alkali cellulose, the measurement of cellulose, in alkali cellulose, resistant to 8% NaOH (maximum solubility) would appear to be preferable as it is a more direct approach.

Characterization of Pulps Via Integrated Filtration and Optical Studies on their Viscoses

MICHAEL GOLBEN

The filterability test in its many forms has been a useful tool in evaluating dissolving pulps by means of their viscoses. It is becoming recognized, however, that filterability data alone do not adequately describe viscose quality for research purposes, and in some cases can be misleading. In an integrated series of tests a standard viscose is prepared from a pulp to be evaluated, examined microscopically, passed through a uniformly prepared filterability unit in a constant rate tester to determine its filtration constant; the five layers of the filterability unit are removed and washed separately, and a classification of the filtered residue obtained by a particle count and/or transmittance and light-scattering measurements made on the water suspensions. In some cases, photomicrographs are taken using the phase microscope. These tests provide data which are supplementary in nature as to interpretation. The pulp is characterized by the filterability constant of its viscose, appearance of the viscose, and a "turbidity profile" and "clarity number" of the suspension of unreacted residue.

Determination of viscose filterability has been a useful supplementary technique in the evaluation of dissolving pulps. A considerable amount of effort has been directed toward the development of reliable filterability methods (*1–5*) and establishment of standard filtration equations and corresponding filterability constants (*6–10*). Nevertheless, there are limitations to such equipment and formulas (*11–15*).

A serious limitation of filterability data exists in that such data often are not adequate for describing viscose quality. The particles of unreacted residue in viscose have complex characteristics, covering a wide range of size distributions, shapes, deformability, and number and weight per unit volume of viscose. The interaction of these characteristics upon filtration through filter media of given physical structure determines the "filterability" of a viscose. However, we are interested in more information than can be given by filterability data, because a significant proportion of these particles may be of such a size and nature that they will pass the filter, yet affect spinnability and yarn quality or appearance. This paper describes techniques which have been developed to extend the filterability evaluation of dissolving pulps, whereby the particles concentrated by filtration can be classified and examined. These nonroutine optical methods include use of the phase microscope and measurements of transmittance and turbidity of water suspensions of particles, which yield transmittance and turbidity "profiles" and a "clarity number." The information so gained can be integrated with the "T-value" obtained by means of a constant rate filterability tester.

For this evaluation, 500 grams of pulp are converted into a viscose of standard specifications.

Michael Golben, Group Leader, Pulp Evaluation Laboratory, American Viscose Corp., Marcus Hook, Pa.

APPARATUS AND PROCEDURES

The constant rate filterability tester shown in Fig. 1 was devised by C. D. Vandenburgh and B. W. Collins of the American Viscose Corp. The essential elements are a positive delivery, constant rate, gear pump A, filter unit B, and pressure recorder C, which records build-up of back-pressure in chamber D. Viscose is gravity-fed to pump from hopper E.

Zenith gear pump A has a capacity of 0.6 cc. per revolution and is run at 41.07 r.p.m. Filter unit B is a standard assembly having a hard rubber casing containing a specially prepared candle filter. The latter is prepared by winding under uniform tension and speed, upon a hard rubber core, four layers of a two-ply yarn of cotton of about 2 denier per filament, having 10.1 turns S-twist per in., with singles 17 count, 12.3 turns Z-twist per in. The fifth and outermost layer is ebonite cloth, double folded at the edges and tied at the ends. Direction of flow is from the outside in and is opposite to that when candle filter is used on a spinning machine. Filter area is 9.65 sq.in.

The apparatus is cleaned thoroughly prior to each use and is kept at a temperature of 18°C. Viscose to be tested is prepared under standard specifications and is aged about 1 day in order to reach the plateau of the viscosity curve and permit large air bubbles to rise. It is poured into the hopper, then the pump and recorder are started. The test lasts $2^1/_2$ hr. Pressure readings are taken from the chart at 15-min. intervals starting at 1 hr. from the beginning of the test. An approximation of the slope of the pressure-time curve is called the T-value, a measure of filterability. A low T-value signifies good filterability. Calculated values are corrected to a standard viscosity as measured by a falling ball method. Correction is made also for viscoses having a cellulose content other than standard.

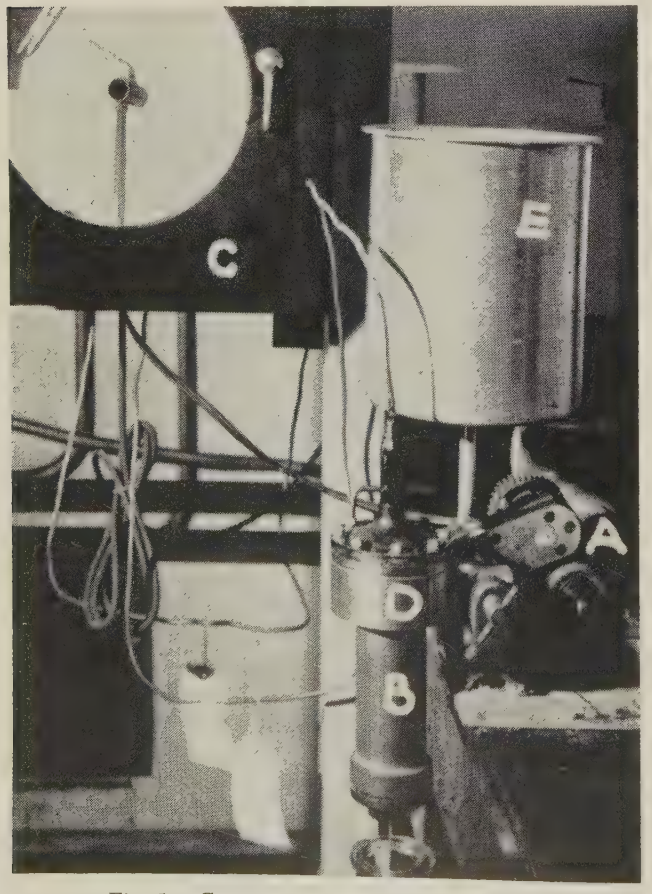

Fig. 1. Constant rate filterability tester

Particle Count Procedure

The filter unit is removed after a standard $2^1/_2$-hr. filterability test and carefully disassembled, avoiding, as much as possible, contact of the filter cloth surface with any other surfaces. First the ebonite cloth is removed and placed in a 400-ml. beaker, followed by unwinding of each of the four layers of cotton yarn, which are then placed in separate numbered beakers. Cloth and yarn are washed, pressed, and rinsed two or more times with distilled water until a total volume of exactly 100 ml. has been accumulated for each layer.

The suspension of washings from the ebonite cloth is agitated by swirling, then 5 ml. are transferred to a small petri dish ($2\ ^1/_4$ in. dia.), covered, and allowed to settle for approximately 15 min. This is repeated with the four remaining beakers. Five fields in each petri dish are examined under a microscope at 100×, adjusting lighting for best contrast (a phase microscope, if available, is best for this work). The particles observed are classified and counted in each field; the total count for five fields is taken as the count for a particular filter layer; the total for the five layers represents the count for the filter unit. The sum of the fiber, fiber gel, gel, and skin counts is the "total particle count" of fiber origin. Other particles, such as "dirt" and "crystals," may be counted also if a more complete characterization is desired.

Particle Description

Fibers: Swollen, unswollen, or partially swollen, having definite outlines. Easily seen in polarized light.

Fiber gels: Bloated fibers, two to three times as large in diameter as swollen fibers. Most internal structure, except for lumen, not visible. Seen only vaguely in polarized light.

Gels: Round shapes with indentation in center, having diameters in the range of fiber gels. Not visible in polarized light, but clearly visible with the phase microscope.

Skins: Irregularly shaped, transparent "sheathes."

Fiber Fragments: Irregular particles of very small size, believed to be caught by adhesion to surfaces of filter media and larger particles. Usually too numerous or too small to count, but may be as large as 3 to 8 mu in dia.

Background Particles: Barely discernible as discrete particles under ordinary microscope, in size range 2 mu and smaller. Contribute to haze in viscose.

Crystals: Roughly faceted particles of irregular shape.

Dirt: Very dark particles of irregular shape and size.

Photomicrographs

A small amount of well agitated suspension is transferred by means of a medicine dropper to a microculture slide with fused cell. The suspended material is allowed to settle before photographing through a phase microscope. Other means of phase differentia-

tion may be used, such as staining or use of a suspending medium having a refractive index widely different from that of the particles.

Turbidity Measurements

The suspensions prepared for particle counts may contain varying amounts of residual viscose as coloring. The five beakers are color corrected roughly to the same shade by addition of small amounts of recently filtered viscose, as required. An aliquot of 25 ml. is taken from each beaker and transmittance measurements made upon it, using an Evelyn Photoelectric Colorimeter (Rubicon Co.) with no. 660 light filter. All five aliquots are then mixed together, and a transmittance measurement is made on the composite. Turbidity measurements are made on similar aliquots and upon a composite sample by the light scattering method, using a Lumetron Photoelectric Colorimeter (Model 402E, Photovolt Corp.) with special pick-up unit for measuring light scattering at 90° angle, again with a no. 660 light filter. These readings constitute a "turbidity profile" when graphed. The ratio of the composite transmittance to the composite turbidity is called the "clarity number."

Discussion of Tests

The procedures described above cover that part of the evaluation of a dissolving pulp which consists of filtration studies on a standard viscose made from the pulp. Obviously the same procedures are applicable when it is desired to investigate viscose process changes, using a standard pulp, or to determine optimum processing conditions for a given pulp. Experience has shown that turbidity data are quite sensitive to processing changes.

With experience, a great deal of qualitative information may be obtained by visual and microscopic examination of fresh viscose. The further tests described above serve as quantitative confirmation of initial observations, but yield further information as well. These tests are integrated in the sense that the same filter clogging particles and adhering material which have been extracted from a standard viscose in the process of determining its filterability value are examined and classified.

Microscopic examination of the residue concentrated by filtration yields information which serves as a basis for interpretation of filterability and turbidity data. For example, the presence of a large proportion of particles of a size intermediate between "filter clogging" and "background" would explain data showing good filterability, but poor clarity.

A particle count is tedious and in most cases can be supplanted for record purposes by photomicrographs and turbidity data. Nevertheless, there are occasional research projects which may require a measure of the variation in proportions of particle constituents for which a particle count alone is suitable. Particle counts may be used to:

1. Establish relative proportions of different types of particles to account for observed filterability behavior.
2. Investigate the effect of process or equipment changes in viscose-making upon relative proportions of particles in the residue.
3. Establish the effect of filtration upon different classes of particles—their depth of penetration and the extent of their disintegration in the process of filtration.

Classification of particles as to depth of penetration of the filter media is afforded by the particle count, transmittance, and turbidity data. Transmittance data, in general, are a measure of the relative abundance and layer of maximum concentration of particles of a size contributing most to filter clogging. Turbidity data by light scattering reveal predominantly the abundance and layer of maximum concentration of small to very small particles most likely to contribute to viscose haze, filament weakness, or yarn "milkiness." Graphing of transmittance or turbidity data for the five layers of the filter unit results in a "transmittance profile" or a "turbidity profile" from which predictions may be made as to efficiency of viscose filtration and the resultant viscose quality. These profiles may reveal, for example, that a viscose made from a particular pulp having poor filterability contains a large number of fibers which are stopped at the first layer, with very few particles of a size small enough to penetrate or pass through the filter. Such viscose will have good quality after filtration; if other information is favorable, there may be sufficient justification for plant trial of this pulp with proper modification of the filter media.

The "clarity number" is simply a convenient way of indicating the combined effect of large and small particles by a single number.

To complete an integrated study of a viscose, the total or separate classifications of the water suspensions may be centrifuged and dried for weight determination, reactivity study, or for inorganic and chromatographic analysis.

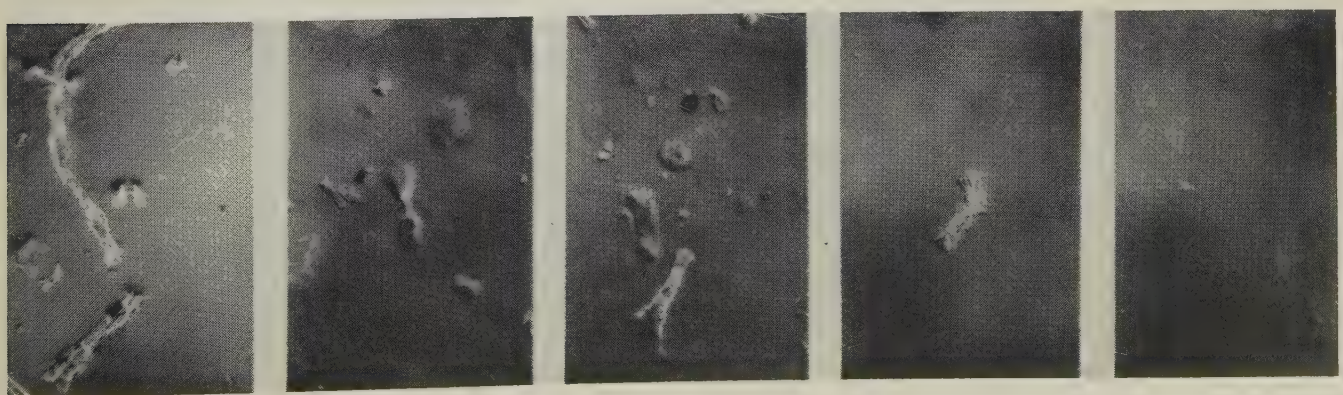

Fig. 2. Wood pulp—particles from five layers of filler unit; 64×

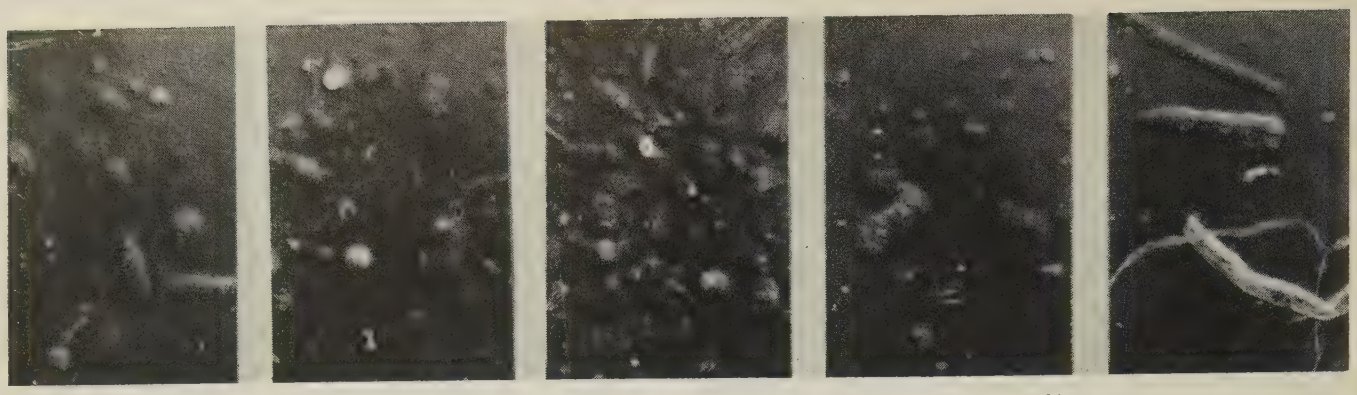

Fig. 3. Cotton linter pulp—particles from five layers of filter unit; 64×

DISCUSSION OF TYPICAL DATA

Photomicrographs

Typical photomicrographs* of particles concentrated by filtration from a wood pulp viscose and from a cotton linters viscose are shown in Figs. 2 and 3, respectively. Washings from the five layers of the filter unit are shown. In Fig. 2 are seen fibers, fiber gels, and dirt particles with numerous fiber fragments. The larger particles occur mostly at layers 1 and 2. The particles recovered from cotton linters viscose (Fig. 3), on the other hand, consist mostly of short fiber gels and circular gels, with the largest concentration occurring at the third layer. The depth of penetration of these particles is evidence of their deformability in passing through the filter pores. There is evidence also of disintegration during passage. The relatively poorer filterability of cotton linters viscose is explainable in terms of the numerous large particles having little if any mat forming characteristic.

The contrast between what is observable with the phase microscope and with polarized light for the same fields is shown in Fig. 4.

Particle Count

Particle counts for a sulphite wood pulp and a cotton linters pulp are compared in parts A and B respectively, of Table I.

These data confirm microscopic and photographic observations, and afford a roughly quantitative comparison and measure of the changes in proportions of particles resulting from pulp or process changes. When different types of pulps are being compared, particle counts cannot be correlated directly with the filterability constant, nevertheless, they often provide specific useful information. For example, a viscose being evaluated may have a poor filterability, yet a particle count may

* The phase microscope was used.

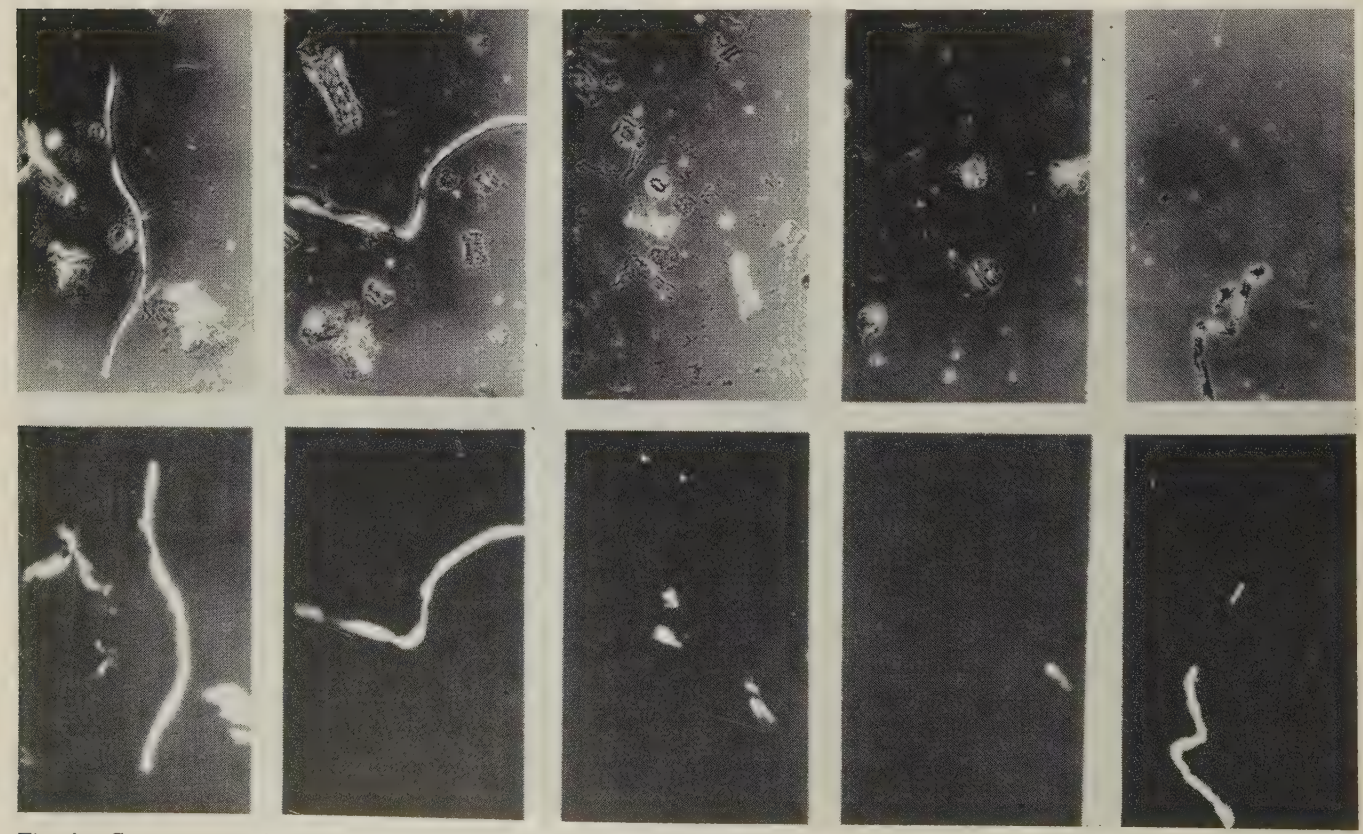

Fig. 4. Comparison of results by phase microscope (above) and polarized light (below); particles from an experimental cotton linters pulp; 64×

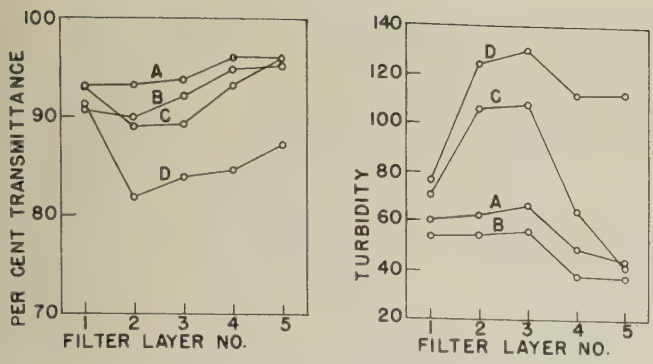

Fig. 5. Comparison of transmittance and turbidity profiles for typical sulphite wood pulps

show that the abundance and proportions of cellulosic particles are normal, but the dirt count is high, accounting for a high T-value.

Transmittance and Turbidity Data

In Fig. 5 are graphed transmittance and turbidity data for four different sulphite wood pulps covering a wide range of clarity numbers. The clarity numbers

Table I. Typical Particle Counts for a Sulphite Wood and a Cotton Linters Pulp

Layer no.	*Fibers*	*Fiber gels*	*Gels*	*Skins*	*Dirt*	*Crystals*
A. Sulphite Wood—T-value = 5.3						
1	11	4	1	9	7	6
2	14	7	2	4	9	4
3	11	1	0	4	11	8
4	2	1	1	1	12	1
5	5	1	0	2	0	0
Total	43	14	4	20	39	19
B. Cotton Linters—T-value = 26.2						
1	29	216	40	0	30	126
2	14	270	23	0	41	139
3	12	416	14	0	35	112
4	8	66	2	0	8	22
5	4	27	5	0	2	0
Total	67	995	84	0	116	399

and T-values for these pulps are given in Table II Pulps A and B have good transmittance profiles; the per cent transmittances are high and improve from layer to layer, with pulp A at the higher level. Their parallel turbidity profiles curiously show a reverse order of levels. Obviously, though viscose from pulp B contains more filter clogging material, which results in a higher T-value, it contains fewer small particles contributing to light scattering; it therefore has a high clarity number. Pulp C viscose shows acceptable filterability by T-value, yet there is evidence in the lower transmittance and higher turbidities at the second and third layers of a large number of smaller particles which penetrate more deeply into the filter media. However, the high transmittance and low turbidity at the fifth layer indicate that the quality of the filtered

Table II. Comparison of Sulphite Pulps

Pulp type	*Clarity no.*	*T-Value*
A	1.65	3.6
B	1.91	7.0
C	1.17	5.5
D	0.74	5.8

Table III. Comparison of Sulphate Pulps

Pulp type	*Clarity no.*	*T-value*
E	1.80	7.3
F	1.97	3.6
G	1.51	2.6
H	2.34	2.8

viscose may be satisfactory, though the viscose may be hazy because of background particles. The effect of the latter is best determined by direct turbidity measurements on the filtered viscose. Pulp D, cellophane grade, has the lowest transmittance and highest turbidity levels, and consequently the lowest clarity number. There is every indication that the low T-value obtained is not representative of high viscose quality,* especially in view of the high turbidities at the fourth and fifth layers.

It is possible also to have a viscose containing particles of a size distribution and nature such that the

Table IV. Comparison of Cotton Linters Pulps

Pulp type	*Clarity no.*	*T-value*
J	1.90	27
J′	1.56	25
K	0.58	21

first layers of the filter are rapidly clogged, with few, if any, smaller particles present. Such a viscose would have a high T-value, but excellent quality after proper filtration.

The graphs in Fig. 6 and the data in Table III, which are typical, show that viscoses made from prehydrolyzed sulphate pulps, in general, have good clarity numbers. Pulp F has a higher clarity number and lower T-value than pulp E and thus rates high in acceptability. Both G and H have even better T-values, yet their transmittance and turbidity profiles are disturbing because of the transmittance down-turns and turbidity upturns at the fifth layers. Both show definite low points in the transmittance profiles, pulp G at the second and H at the third layer, indicating a concentration of larger particles at these points. These observations suggest that the high clarity number and low T-value of pulp H, for example, may be misleading as to viscose quality. A low T-value may result simply be-

* Viscose quality here is an arbitrary term, by which is meant spinnability into good quality continuous filament rayon yarn. Viscose containing numerous particles of a size significantly large with respect to yarn filament diameter will not produce good yarn. Viscose of highest purity may not be required in some cases. The suitability of a particular pulp naturally depends upon its intended specific end use.

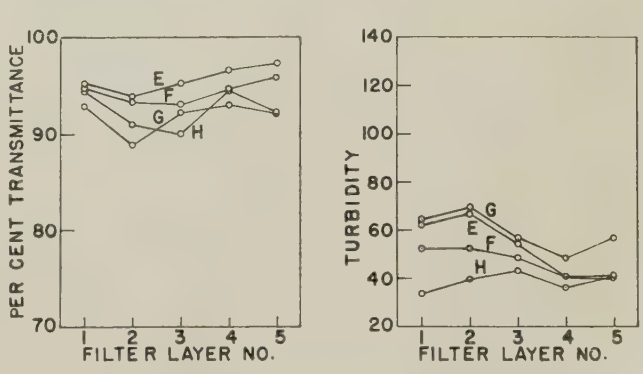

Fig. 6. Comparison of transmittance and turbidity proles for typical sulphate wood pulps

Table V. Effects of Added Residue and Process Change upon Filterability Characteristics of a Sulphite Wood Pulp Viscose

	Transmittance Filter layer no.					Turbidity Filter layer no.						Clarity no.	T-Value
	1	2	3	4	5 Comp.	1	2	2	4	5	Comp.		
Control	94.2	91.9	90.6	94.1	96.2 93.2	61.7	75.7	75.4	56.9	47.3	62.1	1.50	4.2
Residue added	84.8	75.5	79.3	85.9	92.2 83.3	115	173	154	103	68.5	126	0.66	31
Condition 1	78.2	48.2	47.8	59.2	80.2 61.2	168	238	240	205	128	210	0.29	44
2	87.8	64.9	65.8	76.2	83.8 74.9	126	194	188	143	103	166	0.45	34
3	89.7	76.2	72.9	78.8	82.8 79.8	73.3	143	168	128	107	128	0.62	5

cause particles are of the right size and deformability to pass through our filter media. It may be possible, in the plant, to devise a more effective combination of filter media for such viscoses, but this is likely to be costly and should be justified by other advantages to be gained.

Typical data for a cotton linters pulp are illustrated in Fig. 7 and Table IV by pulp J. The line marked J′ is for a viscose made from pulp J under slightly different process conditions. In view of the relatively poor filterability of viscose made from a cotton linters pulp, the high clarity number may seem anomalous. Reference to Fig. 3 shows that the type of particles generally present in cotton linters viscose is difficult to differentiate from the viscose phase. They are not likely to obstruct transmitted light nor to cause light scattering to the same extent as unreacted particles from a wood pulp. It is significant, however, that the turbidity up-turn at the fifth layer previously noticed with sulphate pulps G and H is much stronger for a cotton linters viscose. This effect may be accounted for by assuming that the soft particles, in passing through the filter media, become frayed to the extent that there are formed many more reflectance points contributing to light scattering. The large turbidity effect and relatively small transmittance effect tend to support this viewpoint.

Pulp K is an experimental cotton linters pulp which yields a viscose having filterability equivalent to J and J′ but with much higher turbidity values due to the different nature of residual particles. Photomicrographs of these particles are shown in Fig. 4.

In the above data comparisons are made among several different kinds of pulp. In the interpretation of these data, consideration must be given necessarily to the differences in size distributions, proportions, and characteristics of unreacted residue from pulps of different sources and methods of preparation. Of direct aid in this interpretation are background data which correlate the observations made on viscoses with the strength, elongation, color, and luster of yarns spun from the same viscoses.

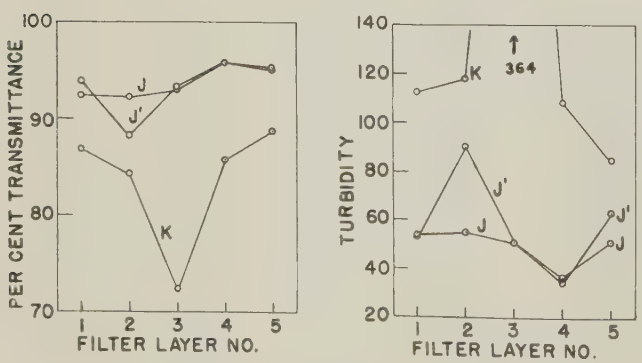

Fig. 7. Transmittance and turbidity profiles for cotton linter pulps

Examples of Other Uses for Evaluation Techniques

In Table V are summarized data showing (1) the effect of adding 0.2% of bleached fibrous residue to a sulphite pulp prior to viscose processing, and (2) the effect of a progressive change in a process variable upon filtration characteristics of viscoses made from a sulphite wood pulp.

The 0.2% of residue fibers, which had been recovered from previous filtrations and bleached with chlorine dioxide, reacted to the extent of 95%. Nevertheless, the remaining 5% unreacted residue fibers had a strong unfavorable effect upon viscose filterability.

The change in viscose process variable is accompanied by higher transmittance readings, lower turbidity readings, and lower T-values.

SUMMARY

Requirements for viscoses made from dissolving pulps may include good filterability, good quality of filtered viscose, and absence of haze. Unreacted residue recovered from viscoses differs greatly in size distributions, classification and proportions of types of particles, and nature of particles, these characteristics being dependent upon the pulp source and method of preparation. Consequently, filterability data alone are inadequate for characterization of dissolving pulp. Methods are described for obtaining a particle count, transmittance and turbidity profiles, and a clarity number, all of which can be integrated with filterability T-value and microscopic examination to provide a more complete evaluation of a dissolving pulp.

LITERATURE CITED

1. Okada, H., and Yamaji, T., *J. Japan. Tech. Assoc. Pulp Paper Ind.* 5: 318–329; English summary, 376, 377 (1951).
2. Winkler, W., *Kunstseide u. Zellwolle* 28: 153–155 (1950).
3. Samuelson, O., *Svensk. Papperstidn.* 51: 331–335 (1948).
4. Neiman, R. S., *Textile Ind. U.S.S.R.* 8: 31 (1947).
5. Takizawa, A., Iuchi, A., and Owashi, T., *J. Soc. Textile and Cellulose Ind. Japan* 9: 164–167 (1953).
6. Takizawa, A., Owashi, T., and Iuchi, A., *J. Soc. of Textile and Cellulose Ind. Japan* 10: 246–249 (1954).
7. Vosters, H. L., *Svensk. Papperstidn.* 54: 539–561 (1951).
8. Matthes, A., *Chem. Tech.* (Berlin) 3: 13–22 (1951).
9. Teunissen, P. H., *Svensk. Papperstidn.* 51: 497–500 (1948).
10. Hermans, P. H., et al., *Rec. trav. chim.* 54: 680–700 (1935).
11. Herrent, P., Ludé, A., Jnoff, G., *Svensk. Papperstidn.* 54: 153–168 (1951).
12. Vosters, H. L., *Svensk. Papperstidn.* 53: 771–782 (1950).
13. Nicolaysen, V. B., and Bergh, W., *Norsk. Skogindustrie* 4: 219–225 (1950).
14. Gonsalves, V. E., *Rec. trav. chim.* 69: 873–903 (1950).
15. Vosters, H. L., *Svensk. Papperstidn.* 53: 29–34; 59–64 (1950).

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ASSOCIATION NEWS AND EVENTS

Local Sections

New England: Curtis Hotel, Lenox, Mass., Sept. 14–15, 1955.

Maine-New Hampshire: Lafayette Hotel, Portland, Me., Oct. 28–29. 1955.

National Conferences

Fifth Fundamental Research Conference, Institute of Paper Chemistry, Appleton, Wis., Sept. 15–17, 1955.

Second Mechanical Pulping Conference, Poland Spring House, Poland Spring, Me., Sept. 19–21, 1955.

Sixth Testing Conference, Hotel Sheraton-Kimball, Springfield, Mass., Sept. 28–30, 1955.

Fifth Corrugated Containers Conference, Morrison Hotel, Chicago, Ill., Oct. 5–7, 1955.

Twelfth Agricultural Fibers Conference, Alton, Ill., Oct. 13–14, 1955.

Ninth Alkaline Pulping Conference, Hotel Patten, Chattanooga, Tenn., Oct. 19–21, 1955.

Tenth Engineering Conference Rice Hotel, Houston, Tex.

Tenth Plastics-Paper Conference, Brooklyn Law School, Brooklyn, N. Y., Nov. 14–15, 1955.

Forty-First Annual Meeting, Commodore Hotel, New York, N. Y., Feb., 20–23, 1956.

Seventh Coating Conference, Benjamin Franklin Hotel, Philadelphia, Pa., May 7–9, 1956.

Report of the Nominating Committee

The TAPPI 1956 Nominating Committee consisting of R. S. Hatch, Hudson Pulp & Paper Co., New York, N. Y., chairman; D. D. Uong, Fitchburg Paper Co., Fitchburg, Mass.; J. N. Stephenson, *Pulp & Paper Magazine of Canada,* Gardenvale, Que.; A. S. O'Brien, Eastman Kodak Co., Rochester, N. Y.; and F. A. Simmonds, Forest Products Laboratory, Madison, Wis., have presented the following nominees for officers and executive committeemen to be voted on by the Association membership prior to the TAPPI Annual Meeting in 1956.

President (one year): Karl O. Elderkin, Bowaters Southern Paper Corp., Calhoun, Tenn.

Vice-President (one year): Ward D. Harrison, Riegel Paper Corp., Milford, N. J.

Executive Committeemen (three years): Harold M. Annis, Oxford Paper Co., New York, N. Y.; Philip S. Bolton, Robert Gair Co., Uncasville, Conn.; Olin W. Callighan, Minerals & Chemicals Corp. of America, Edgar Div., Kalamazoo, Mich.; and Harry S. Spencer, Howard Smith Paper Mills, Beauharnois, Que.

Note: Article VII, Sec. 3 TAPPI Constitution: Other nominations, if signed by at least 25 voting members, may be submitted to the Secretary of the Association, in writing, on or before November 20, and if each nomination so made is accepted in writing by the nominee, the name shall be placed on the official ballot."

Process Instrumentation and Control Committee

Process instrumentation and control is today being extensively used in the paper and pulp industry. For this reason the TAPPI Engineering Division is sponsoring a new committee whose efforts will be devoted entirely to this subject. This committee will serve as a clearing house for the latest advances in the use of instruments to improve quality and lower cost. The committee's first annual meeting will be held at the Tenth Engineering Conference in Houston, Tex., this Fall.

It is evident that the benefits derived from each member's company, its individual employees, and the industry as a whole will depend on the active participation of the Association members. It is very likely that these benefits will be substantial.

Employees of pulp and paper companies who are actively interested in the application of instrumentation and control to the processes of the industry are invited to serve as members of this committee. Anyone interested in doing so should write to the Secretary of TAPPI, 155 E. 44th St., New York 17, N. Y.

Tenth Engineering Conference

The Tenth Engineering Conference of the Technical Association will be held at the Rice Hotel, Houston, Tex.

The following committees have been established to handle the details of the meeting:

Advisory Committee: Karl M. Bendetson, Champion Paper & Fibre Co., Pasadena, Tex.; R. M. Buckley, East Texas Pulp & Paper Co., Evadale, Tex.; and W. L. McHale, Southland Paper Mills, Lufkin, Tex.

Local Arrangements Committee: Stephen Chase, Jr., Champion Paper & Fibre Co., chairman; David C. Edmiston, Southland Paper Mills, and John Hartman, East Texas Pulp & Paper Co., co-chairmen; J. K. Pound, Champion Paper & Fibre Co., consultant, and R. W. Kent, secretary-treasurer

Publicity Committee: J. W. Rushing, Champion Paper & Fibre Co.

Registration Committee: G. A. Jackson, Champion Paper & Fibre Co.

Mill Tours Committee: J. L. Henderson, Champion Paper & Fibre Co.

Hotel Arrangements Committee: T. W. Edwards, Champion Paper & Fibre Co.

Hospitality Committee: H. M. Burnette, Champion Paper & Fibre Co.

Seventh Coating Conference

J. T. Loomer, Robert Gair Co., Uncasville, Conn., general chairman of the Seventh TAPPI Coating Conference to be held at the Benjamin Franklin Hotel, May 7–9, 1956, announces that definite plans have been made for trips to the Hercules Powder Co., Experimentation Station in Wilmington, Del., and the new Du Pont Polychemicals Department Laboratory at Chestnut Run, Del.

The theme of the conference will be "Synthetic Adhesives for Coating." Any person or company that may desire to present a paper within the scope of the subject should write to Chester G. Landes, American Cyanamid Co., 1937 W. Main St., Stamford, Conn.

Fifth Corrugated Containers Conference

The Fifth Corrugated Containers Conference will be held at the Morrison Hotel, Chicago, Ill., on Oct. 5–7, 1955.

K. R. Martin of the Fort Wayne Corrugated Paper Co., Hartford City, Ind., will be general chairman of the meeting.

The group from England which visited a number of Canadian pulp and paper mills early this Summer together with several representatives of the Canadian pulp and paper industry

The technical program will be presented on October 5. There will be two sessions. The morning session on "Single Facer Innovations," will be moderated by Burt Mendlin, Cornell Paper Products Co., Milwaukee, Wis., and the afternoon session on "New Developments in Die Cutting," will be moderated by W. P. Blamire, American Boxboard Co., Grand Rapids, Mich.

On October 6 and 7 there will be visits to the Stone Container Co. and the Fort Wayne Corrugated Paper Co. plants in Chicago.

The TAPPI Chicago Section, Arthur C. Dreshfield, Chicago Testing Laboratories, Chicago, Ill., chairman, will take care of local arrangements. A. L. Magnusson, Kelco Co., Chicago, Ill., will be chairman of the Registration and Transportation Committee.

H. T. Scordas, Union Bag & Paper Co., Savannah, Ga., is chairman of the Corrugated Containers Committee.

Ninth Alkaline Pulping Conference

The Ninth Alkaline Pulping Conference will be held at the Hotel Patten, Chattanooga, Tenn., on Oct. 19–21, 1955. Malcolm B. Pineo is chairman of the Alkaline Pulping Committee. David Wetherhorn of the Southern Paperboard Co., Port Wentworth, Ga., is technical program chairman. Moderators of the technical sessions will be T. T. Collins, Hudson Pulp & Paper Co., Palatka, Fla.; John Goss, Gaylord Container Corp., Bogalusa, La., and Vernon Woodside, Olin-Mathieson Chemical Corp., New Orleans, La. George Koons, Bowaters Southern Paper Corp., Calhoun, Tenn., will be in charge of local arrangements. Junius Sapp of the Gaylord Container Corp. is organizing a session on semichemical pulping.

The following papers will constitute the program of the alkaline pulping session:

"A Wood Study at the Brunswick Pulp & Paper Co. Mill"
"Magnetic Flow Meter of Foxboro Co."
"Practical Application of Statistics to Black Liquor Vacuum Washers," by William Simmons, St. Joe Paper Co., Port St. Joe, Fla.
"The Thermal Conductivity of Black Liquor," by William Harvin, University of Florida, Gainesville, Fla.
"New Developments in Cleaning Recovery Boilers," by P. H. West, Thilmany Pulp & Paper Co., Kaukauna, Wis.
"New Developments in Causticizing Practices," by Dorr-Oliver, Inc.
"New Developments in Tall Oil," by the Tall Oil Association
"Substitute for Salt Cake and Sulphur," by A. W. Pesch, International Paper Co., Mobile, Ala.
"Deterioration of Southern Kraft Pulp in High Density Storage," by J. E. Ayer, University of Alabama, Tuscaloosa, Ala.
"Digester Corrosion Study," by F. Loschbrandt, Norwegian Pulp & Paper Research Institute, Oslo, Norway
"The Effect of Recycled Black Liquor in Sulphate Pulping," by Victor Mattson, Mead Corp.

The program for the Semichemical Pulping Session is as follows:

"Penetration and Diffusion in Wood II. Comparison of Sodium and Ammonium Sulphates as Shown by Burning," by J. E. Stone, Institute of Paper Chemistry, Appleton, Wis.
"High Yield Sulphite Pulping-Polar," by W. D. Kerr and S. A. Harding, Pulp & Paper Research Institute of Canada, Montreal, P. Q.
"Neutral Sulphite Semichemical Pulping of Barked and Unbarked Hickories," by E. L. Keller, Forest Products Laboratory, Madison, Wis.

Tenth Paper-Plastics Conference

The Tenth Paper-Plastics Conference will be held at the Brooklyn Law School, Brooklyn, N. Y., on Nov. 14–15, 1955. J. C. Pullman of the American Cyanamid Co., is chairman of the TAPPI Plastics Committee.

The general theme of the meeting will be "Fibers and Plastics for Laminates."

H. F. Mark of the Polytechnic Institute of Brooklyn will be general chairman of the Conference. W. L. Hardy of Foster D. Snell, Inc., New York, N. Y., will be Technical Program Committee chairman, and R. Lindenfelser of the American Cyanamid Co. is local arrangements chairman.

TAPPI Overseas Discussion Group

Members of TAPPI located in European countries met in Paris, France, on May 20–21, 1955. About 100 members were present. There are 550 Association members in Europe. The meeting was sponsored by L'Association Technique de l'Industrie Papetiere.

Raoul Naville, technical director of Pavig A/G, Zurich, Switzerland, was elected president and Ian F. Hendry of Wiggins Teape & Co. Ltd., High Wycombe, Bucks, England, was elected secretary. Two vice-presidents were chosen: Ewald Schoeller of Ewald Schoeller & Co, Duren, Germany, and Georges Franck of Cartonneries de la Rochette, Paris, France

The following were elected to the board of delegates representing their respective countries:

Austria—Karl J. Adamik, Technical Hochschule, Graz
Belgium—Pierre Ceuterick, Papeteries de Belgique
Denmark—Powl Hermann, Junkers Sagvarek
Finland—Pekka Haarla, Haarla Paper Mill Co.
France—Georges Franck, Cartonneries de la Rochette
Germany—Ewald Schoeller, Ewald Schoeller & Co.
Great Britian—Ian F. Hendry, Wiggins Teape & Co.
Hungary—Georges Vamos, Paper Research Institute
Italy—Germane Centola, Stazione Sperimentale per la Cellulose
Netherlands—F. M. Muller, Netherlands Experimental Station for the Utilization of Straw
Spain—Alvarez Nova, Tableros de Fibras
Switzerland—Raoul Naville, Pavig A/G

It is probable that the 1956 meeting will be held in England.

In response to the announcement concerning the first meeting 270 members expressed an interest in the formation of the discussion group. Of these, about 210 persons expressed a desire to become members of the group.

At the technical sessions held on May 20 and 21 the following papers were presented:

1. "Hydrotropic Digestion of Tropical Woods," by A. Robert Traynard, Ecole Francais de Papeterie, Grenoble, France.
2. "*Ailanthus glandulosa* as Pulpwood," by K. Adamik, Technische Hochschule, Graz, Austria.

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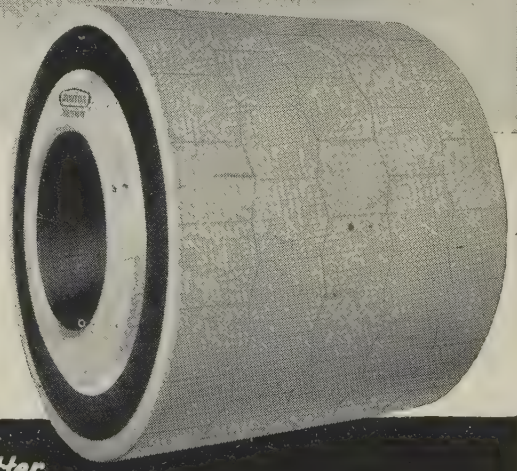

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3. "Point of View on Neutral Sulphite Semichemical Pulping," by O. H. Roland, Runkel-Reinbek, Germany.
4. "Hemicelluloses of the Sea Pine: Isolation of the Uronic Acid and Aldo-Uronic Acids Obtained by Partial Hydrolysis of These Hemicelluloses," by A. Rondier and L. Eberhard, Laboratoire Central des Services Chimiques de l'Etat, Paris, France.
5. "A Simple Apparatus for Freeness Testing and for the Preparation of Samples for Brightness Testing," by Fred C. Aldred, Courtaulds Ltd., Coventry, England.
6. "Some Colloid Chemical Aspects of the Sizing of Paper," by C. J. J. Ninck Blok, Van Gelder Zonen, Velsen, Netherlands.
7. "The Sulzer Process for Water Removal," by R. Thoman, Sulzer Freres S/A, Winterthur, Switzerland.
8. "Suction Couches and Presses: Their Effect on Water Removal and Sheet Properties," by I. F. Hendry, Wiggins Teape Group Research Organization, Glory Mill, High Wycombe, England.
9. "Distribution of Fillers in the Sheet," by G. Centola and D. Borruso, Stazione Sperimentale per la Cellulose, Milan, Italy.
10. "The Retention in Paper of Sulphur Present in Anionic Urea Formaldehyde Resins, and the Migration of Resin During Drying Tests with Radio-active Sulphur," by F. L. Hudson and H. James, B.I.P. Chemicals Ltd., Aldbury, England.
11. "Testing Methods for Practical Control of Corrugated Board," by E. Kraemer, Mannheim-Rheinan, Germany.
12. "Evaluation of Durability and Printability of Rag Papers," by K. E. C. Buyer, Joh. Enschede & Sons, Haarlem, Netherlands.

Following the technical sessions a visit was made to the printing paper and writing paper mill of Papeteries de Pont Sainte-Maxence near Paris A three-day tour of mills was made on May 23 to 25 which included inspection of mills of Papeteries de Condat at Condat-le-Lardin (Dordogue); Isorel at Castlejaloux (Lot and Garonne); Soc. Landaise des Celluloses at Tartas (Laudes); Cellulose du Pin at Facture (Gironde); Cellulose d'Alizay at Alizay (Eure); Papeteries de la Chapelle at Saint Etienne du Rouvray.

In July, 1954, Hermann F. J. Wenzl of Lucerne, Switzerland, suggested to the TAPPI Executive Committee that a European Overseas Discussion Group be established to bring together the members of the Technical Association in the European countries.

No official action was taken by the TAPPI Executive Committee which approved the action in principle but hesitated to agree to participate actively because of the possibility of misunderstanding of Association objectives. Advice was requested from representatives of some of the established Associations in Europe.

The French A.T.I.P. took the initiative and sponsored a successful meeting. TAPPI was not officially represented although some of its members in the United States and Canada were present.

The Association, as such, has never organized any of the groups that have become local sections. Such groups have operated as independent bodies for a period of time until they showed evidence of being permanent bodies, at which time they received charters as sections. The Association's attitude toward member groups located outside of the United States will require considerable study. Meanwhile, any worthwhile effort by any group of its members will receive encouragement and support consistent with the best interest of the Association and its members.

Second Mechanical Pulping Conference

Well-known technical speakers from four countries appear on the program of the Second International Mechanical Pulping Conference Sept. 19–21 at Poland Spring, Me.

Many representatives from leading pulp and paper mills throughout the world have signified their intentions of attending this conference. In addition to the technical program there will be arranged tours of local mills and displays of products using groundwood pulp.

A complete program has been arranged for the ladies including a visit to the Bates Manufacturing Co., makers of fine textiles and a visit to the television broadcasting station. Several teas and receptions are also scheduled. Excellent facilities for golf and tennis are provided by the hotel.

The official conference program is as follows:

Monday, Sept. 19, 1955

8:00 a.m. *Registration*

9:45 a.m. *General Chairman's Opening Remarks*—T. F. LaHaise, General Superintendent, Imperial Paper & Color Corp., Plattsburg, N. Y.

10:00 a.m. *General Session*—W. Gallay, Director of Research, The E. B. Eddy Co., Hull, Que., *Chairman*

1. "Characteristics and Potentials of Groundwood," by W. Gallay.
2. "The Grinding Process—Basic Approach," by D. Atack, Pulp and Paper Research Institute of Canada, Montreal, Que.
3. "Groundwood Production Related to Fiber Technology," by K. Klemm, Northeastern Paper Products, Ltd. Quebec, P. Q.

2:00 p.m. *Wood Utilization Session*—F. W. O'Neil, Head of Dept. of Pulp & Paper Technology, New York State University, College of Forestry, Syracuse, N. Y., *Chairman*

1. "Conservation and Utilization of Wood for Mechanical Pulping," by R. W. Marquis, Northeastern Experiment Station, U. S. Dept. of Agriculture, Upper Darby, Pa.
2. "The Grinding of Pretreated Hardwoods," by A. Hyttinen and E. R. Schafer, Forest Products Laboratory, Madison, Wis.
3. "Caustic Treatment of Aspen Groundwood," by W. J. Foote and S. R. Parsons of Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis.
4. "Commercial Production of Chemigroundwood for Newsprint," by J. H. Heuer, Great Northern Paper Co., East Millinocket, Me.

7:00 p.m. *Banquet*—Speaker: James L. Ritchie, Executive Director, United States Pulp Producers Association, New York, N. Y. Subject: "The Groundwood Economy"

Tuesday, Sept. 20, 1955

9:30 a.m. *General Session*—Karl Pingrey, Mill Manager, Diamond Match Co., Ogdensburg, N. Y., *Chairman*

1. "Pitless Grinding," by C. Anker, Risor Tremassefabrikken Risor, Norway.
2. "The Norton-Great Northern Research Stone," D. M. Chisholm, Managing Director, Norton Company of Canada Ltd., Hamilton, Ont. Introduction by J. H. Heuer, Great Northern Paper Co., Millinocket, Me.

10:30 a.m. *Panel Session*—W. J. Foote, Mill Manager, Consolidated Water Power & Paper Co., Stevens Point, Wis., *Chairman.*

"Regional Aspects for the Production of Groundwood for Printing and Specialty Papers"

Panel:

W. H. Kraske, Oxford Paper Co., Rumford, Me.
G. A. McCracken, Provincial Paper Co., Port Arthur, Ont.
W. J. Walker, Champion Paper & Fibre Co., Pasadena, Texas

2:00 p.m. *Panel Sessions*—N. F. Robertson, Mill Manager, West Tacoma Newsprint Co., Steilacoom, Wash., *Chairman*

1. "Regional Aspects of the Production of Groundwood for Board and Container Grades."

Panel:

C. I. Gehring, Oswego Falls Corp., Fulton, N. Y.
C. Campbell, Fraser Companies Ltd., Edmundston, N. B.

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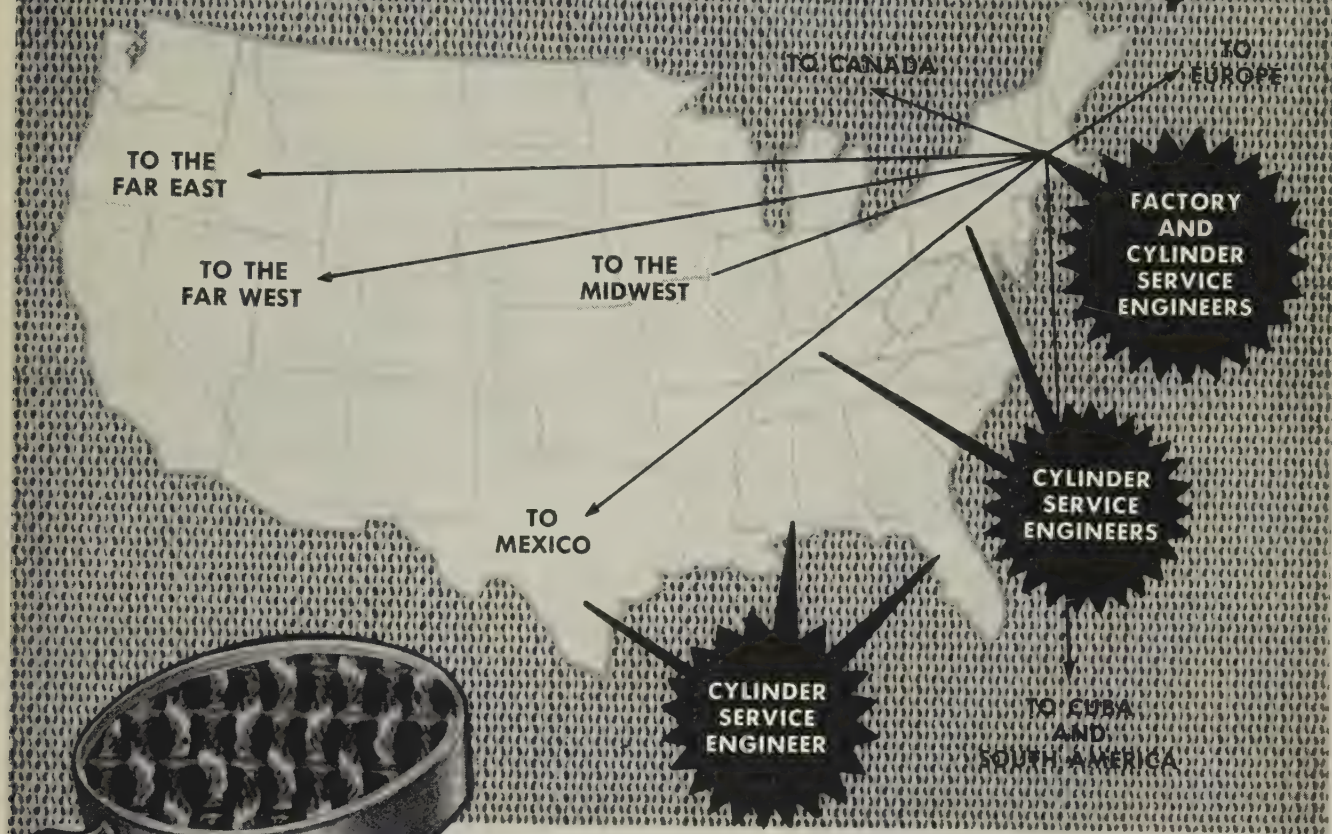

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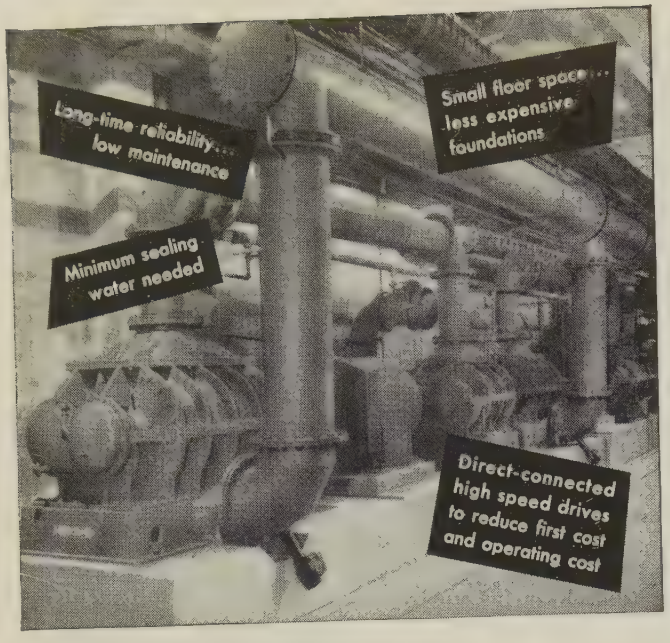
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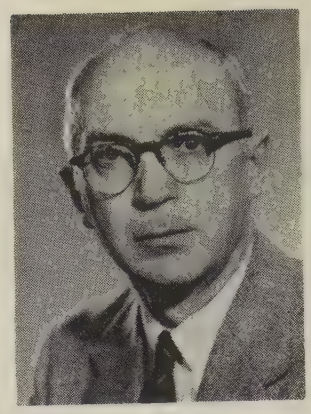


W. H. de Montmorency, Pulo & Paper Research Institute of Canada

R. H. Simmons, Government Printing Office, Chairman, Program Committee, TAPPI Testing Conference

2. "Regional Aspects of the Production of Groundwood for Tissue and Toweling."
   Panel:
   H. W. Hillier, Scott Paper Co., Chester, Pa.
   E. Johnson, Stevens & Thompson Co., Greenwich, N. Y.
   C. Malcolm, E. B. Eddy Co., Hull, Que.

8:00 p.m. *Refining Session*—T. G. Rust, Assistant General Supt., Quebec North Shore Paper Co., Baie Comeau, Que., *Chairman*

1. "Low Consistency Refining of Groundwood Rejects at Spruce Falls Power and Paper Co., Ltd.," by R. H. Stafford and E. Gardiner, Spruce Falls Power and Paper Co., Kapuskasing, Ont.
2. "The Reisten Refiner," E. P. Walsh, Anglo-Canadian Pulp and Paper Mills Ltd., Que.

Wednesday Sept. 21, 1955

9:30 a.m *Panel Session*—Jack Cairnie, Groundwood Supt., Ontario Paper Co., *Chairman;* George Shipman, General Supt., Pulp & Paper Mills, Donnacona Paper Co., *Moderator*

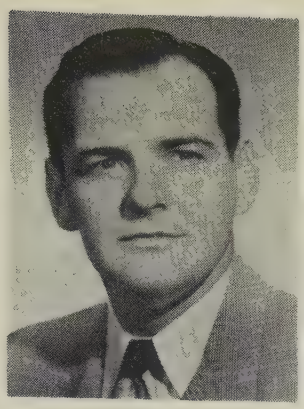
"Regional Aspects for the Production of Groundwood for Newsprint"
Panel:
C. C. Porter, Southland Paper Mills, Lufkin, Texas
W. F. Daniell, Great Northern Paper Co., Millinocket, Me.
H. A. Peterson, Mersey Paper Co , Liverpool, N. S.
N. F. Robertson, West Tacoma Newsprint Co., Steilacoom, Wash.

2:00 p.m. *Symposium*—"Cleaning and Bleaching"—J. L. Parsons, Consultant, Waterville, Me., *Chairman*

A. Cleaning
   1. "The Use of Pressure-Drop Cleaners, i.e., Dirtecs, Bauer Cleaners, etc., in Groundwood Production."
   Short talks on mill operations by:
   J. Moynihan and K. A. Kirkpatrick, Bowaters Southern Paper Corp., Calhoun, Tenn.
   T. G. Shepherd, Donnacona Paper Co., Donnacona, Que.
   G. C. Cole, Finch, Pruyn Co., Glens Falls, N. Y.

B. Bleaching
   1. "Peroxide Bleaching," by R. C. Osborn, Finch, Pruyn & Co., Inc.
   2. "Zinc Hydrosulphite Bleaching of Groundwood," by D. B. Sparrow, Scott Paper Co.
   3. "Multistage Bleaching of Groundwood, Using Peroxide and Zinc Hydrosulphite," C. A. Richardson, Blandin Paper Co., Grand Rapids, Minn.

C. L. Reece, Westfield River Paper Co.; Chairman, Registration Committee, TAPPI Testing Conference



R. W. Ramsdell, Hercules Powder Co., Chairman, Local Arrangements Committee, TAPPI Testing Conference

4. "Summary of Bleaching Methods for Groundwood," by A. A. Yankowski, Kimberly-Clark Corp., Neenah, Wis.

The general chairman of this conference is Thomas F. LaHaise, general superintendent of the Imperial Paper and Color Corp., Plattsburg, N. Y. John H. White of Keyes Fibre Co., Waterville, Me., and William H. de Montmorency of the Pulp and Paper Research Institute of Canada, Montreal, are co-chairmen of the Program Committee.

Early reservations indicate a capacity attendance and you are urged to contact Daniel A. Barry, Jr., manager of the Poland Spring House, Poland Spring, Me., for accommodations.

The Local Arrangements Committee is headed by A. E. Jones, Oxford Paper Co., Rumford, Me.

Sixth Testing Conference

The Sixth Testing Conference of the Technical Association of the Pulp and Paper Industry will be held at the Sheraton-Kimball Hotel, Springfield, Mass., on Sept. 28–30, 1955. It is being sponsored by the TAPPI Testing Division, J. P. Casey, A. E. Staley Mfg. Co., Decatur, Ill., general chairman.

Conference Committee:

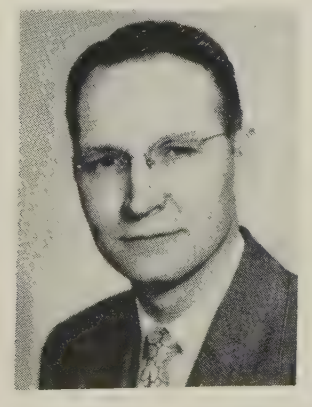
J. P. Casey, General Chairman, Testing Division, A. E. Staley Mfg. Co., Decatur, Ill.

P. W. Bartholomew, General Chairman, Sixth TAPPI Testing Conference, Minnesota and Ontario Paper Co., International Falls, Minn.

R. W. Ramsdell, Local Arrangements, Hercules Powder Co., Holyoke, Mass.

R. H. Simmons, Program, U. S. Government Printing Office, Washington, D. C.

E. E. Stephenson, Sutherland Paper Co., Chairman, Routine Control Methods Committee



A. R. Ewing, Bemis Bros. Bag Co., Chairman Shipping Sack Testing Committee

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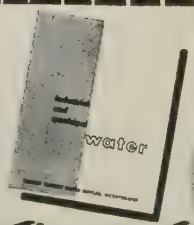

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C. L. Reece, Registration, Westfield River Paper Co., Inc., Russell, Mass.

Program

Tuesday (evening) Sept. 27—Registration and Exhibits of Testing Equipment

Wednesday, Sept. 28, 1955

8:00 a.m.—Registration

9:00 a.m.—General Session

J. P. Casey, A. E. Staley Mfg. Co., Decatur, Ill., *Chairman*

1. "Routine Control Methods," by E. E. Stephenson, Jr., Sutherland Paper Co., Kalamazoo, Mich.
2. "The Analysis of Variance Applied to Paper Sizing Experiments," by William Wooding, American Cyanamid Co., Stamford, Conn.

10:00 a.m.—Committee Meetings

Assignment of rooms for the various committee meetings will be announced at the general session and will be posted on the bulletin board.

12:30 p.m.—Noon Luncheon

2:00 p.m.—Committee Meetings

Continuation of the morning sessions.

4:30 p.m.—Exhibits of Testing Equipment

6:00 p.m.—Committee Chairmen and Steering Committee Dinner

Thursday, Sept. 29, 1955

8:00 a.m.—Registration

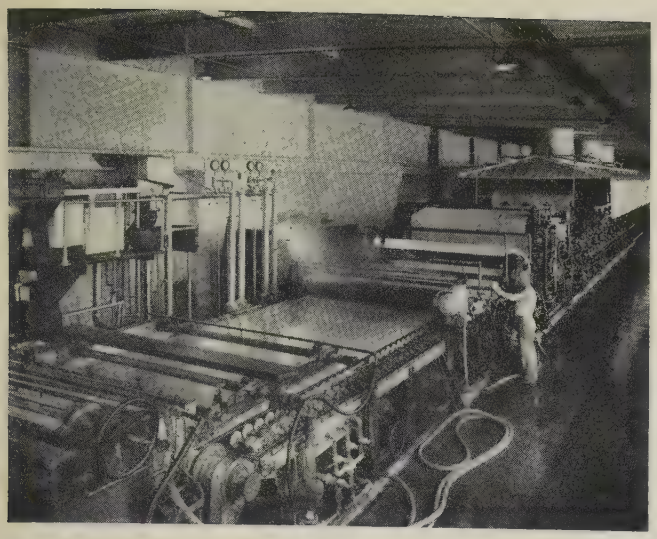
9:00 a.m.—Paper Testing Symposium

1. "A Study of the Dirt in Pulp Determination Results of Round Robin Tests," by Frank E. Caskey, Morden Machines Co., Portland, Ore.
2. "Water Vapor Permeability of Sheet Material Results of Round Robin Tests," by T. E. Dobbins, American Can Co., Maywood, Ill.
3. "Relation between Surface Hardness and Blocking Temperature for Paraffin Waxes," by K. G. Arabian, S. Marple, Jr., and G. P. Hinds, Jr., Shell Oil Co., Houston, Tex.
4. "Moisture Gain and Loss in Kraft Paper and Board," by J. S. Moore, Union Bag & Paper Corp., Savannah, Ga.
5. "The Handle-O-Meter and Quality Control in Testing Tissue," by Ralph Green, Thwing-Albert Instrument Co., Philadelphia, Pa.

12:30 p.m.—Noon Luncheon

2:00 p.m.—Paper Testing Symposium

1. "Comparative Tests of the Bekk and Sheffield Smoothness Testers,"



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by T. W. Lashof, National Bureau of Standards, Washington, D. C.

2. "The Determination of the Permeability Constant of Gases and Vapors by High Vacuum Technique," by John Meyer, V. T. Stannett, and M. Szwarc, College of Forestry, State University of New York, Syracuse, N. Y.
3. "Significance of Heat-Seal Strength Tests," by Lois V. Hans, Quartermaster Research and Development Center, U. S. Army.
4. "The Determination of Starch in Paper," by J. L. Harvey and B. W. Forshee, National Bureau of Standards, Washington, D. C.

4:30 p.m.—Exhibits of Testing Equipment

6:30 p.m.—Banquet

Address: "Paper Testing" by A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt. Mr. Bachmann will be introduced by Miss Helen U. Kiely, American Writing Paper Co., Holyoke, Mass.

Friday, Sept. 30, 1955

9:00 a.m.—General Session at Tecnifax Corp., Holyoke, Mass.

1. "A Study of Paper Composition by Parallel Sectioning," by B. L. Browning and Irving H. Isenberg, Institute of Paper Chemistry, Appleton, Wis.
2. "Testing of Tecnifax Products," by David P. Habib, Tecnifax Corp., Holyoke, Mass.

Plant visit at the Tecnifax Corp.

12:00 Noon—Luncheon

2:00 p.m.—Plant Visit

Strathmore Paper Co., Woronoco, Mass.

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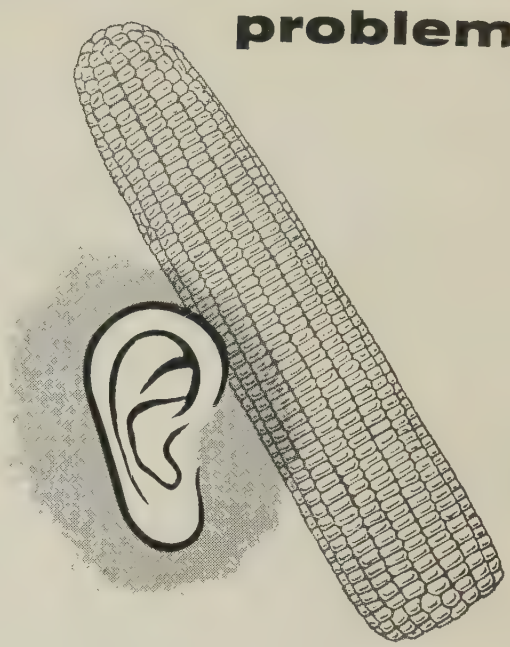

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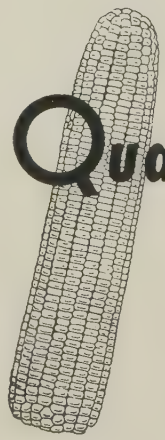

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Gilbert H. Bancroft, Consulting Engineer, Gilbert H. Bancroft Ltd., Vancouver, B. C., Canada. Attended Bradford Technical College.

Alexandre Berzins, Technical Director, Papeterie de la Seine, Nanterre (Seine), France.

Richard H. Bishop, General Superintendent, Minas Basin Pulp & Power Co. Ltd., Hantsport, N. S., Canada, a 1929 graduate of Acadia University.

W. Peyton Blamire, Technical Superintendent, Box Plants, American Box Board Co., Grand Rapids, Mich., a 1941 graduate of Lehigh University.

Fred E. Boeckh, Assistant General Manager, Minnesota & Ontario Paper Co., International Falls, Minn., a 1928 graduate of Iowa State College.

Jean Boudou, Engineer, L'Air Liquids, Paris, France, a graduate of the Central College of Arts and Manufacturing.

Arthur Bourke, Technical Service Supervisor for Paper, National Adhesives (Canada) Ltd., Lachine, P. Q., Canada, a 1946 graduate of McGill University.

George E. Boyce, Chief Engineer, Hinde & Dauch Paper Co. of Canada Ltd., Toronto, Ont., Canada. Attended the University of Toronto.

Jerome P. Brezinski, Research Chemist, Minnesota & Ontario Paper Co., International Falls, Minn., a 1955 graduate of the Institute of Paper Chemistry.

P. L. Thibaut Brian, Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass., a 1951 graduate of Louisiana State University.

Noel F. Browne, Managing Director, Bone Brothers Ltd., Alperton, Wembley, Middx., England.

Henri R. Brunaud, Direct or General, Le Materiel Cellulosique & Papetier, Vienne (Isere) France, a graduate of École Francaise de Papeterie, Grenoble.

Vincent J. Calise, Sales Development Manager, Graver Water Conditioner Co., New York, N. Y., a 1940 graduate of the College of the City of New York.

Francis B. Catanzaro, Chemist, Johnston Foil Mfg. Co., St. Louis, Mo., a 1950 graduate of St. Louis College.

Jean Y. Chartrand, Chief Chemist, Rolland Paper Co., St. Jerome, P. A., Canada, a 1946 graduate of the University of Montreal.

Joseph P. Corbin, Chemical Engineer, St. Regis Paper Co., Deferiet, N. Y., a 1951 graduate of the University of Maine.

Charles W. Dawson, Engineer, Chas. T. Main, Inc., Boston, Mass., a 1932 graduate of the Stockbridge School of Agriculture.

Robert W. Edwards, II, Sales Engineer, A. E. Staley Mfg. Co., Decatur, Ill., a 1952 graduate of the University of Texas.

Charles E. Feazel, Head, Plastics and Polymers Sec., Southern Research Institute, Birmingham, Ala., a 1941 graduate of Harvard University, with a Ph.D. degree from the University of Maryland in 1953.

Fabio G. Fonda, Technical Manager, South African Industrial Cellulose Corp., Umkomhas, South Coast, Natal, S. A., a 1940 graduate of the University of Bologna, Italy.

Ralph L. French, Engineering and Architectural Design, Great Northern Paper Co., Millinocket, Me. Attended Rhode Island University.

Yusaku Fukuda, Director of Research Institute, Nippon Pulp Industrial Co., Yonago-city, Tottori Pref., Japan, a 1935 graduate of the First Technical University, Kyoto, with a D. of Tech. degree.

Henry J. Fuller, Project Engineer, P. H. Glatfelter Co., Spring Grove, Pa., a 1949 graduate of the University of Wyoming.

Peter S. Gates, Director of Quality Control, A. Geo. Schulz Co., Milwaukee, Wis., a 1939 graduate of the University of Chicago, with an L.L.B. degree from John Marshall Law School in 1953.

Leon Gervais, Chief Chemist, Canadian International Paper Co., LaTuque, P. Q., Canada, a 1927 graduate of Laval University, with an L.SC. degree in 1935.

John L. Glucky, Plant Manager, Supervine Paper Mills, Inc., Clayville, N. Y. Attended New York State Teachers College, Oneonta.

Richard E. Green, Mill Manager, Empire Paper Mills Ltd., Greenhithe, Kent, England.

Emerson Greenaway, Director, The Free Library of Philadelphia, Philadelphia, Pa., a 1927 graduate of the University of Massachusetts, and a 1935 graduate of the University of North Carolina.

Karl F. Gustafsson, Sulphite Superintendent, A/B Stjernfors-Stalldalen, Stalldalen, Sweden, a 1946 graduate of the Royal Institute of Technology, Stockholm.

Robert A. Heywood, Sales Engineer, Albany Felt Co. of Canada Ltd., Cowansville, P. Q., Canada.

Tadashi Hisamoto, Engineer, Hitachi Electric Wire Works, Hitachi, Ltd., Ibaragi-Ken, Japan, a 1937 graduate of Tokyo Imperial University, with a Dr. of Engr. degree.

Joseph C. Hottzinger, Development Engineer, Charles Bruning Co., Inc., Teterboro, N. J., a 1947 graduate of Pennsylvania State College.

Hiroshi Hori, Graduate Student, State University of New York, College of Forestry, Syracuse, N. Y.

Edward Hutchinson, Chief Engineer, Ramsbottom Paper Mill Co. Ltd., Ramsbottom, Lancs., England.

Gordon C. Inskeep, Associate Editor, American Chemical Society, New York, N. Y., a 1943 graduate of Ohio State University.

Masayuke Ito, Planning Manager, Yuko Seitai K. K., Osaka-fu, Japan, a 1925 graduate of Waseda University.

Russell F. Jagoditsh, Chief Chemist, Chase Bag Co., Chagrin Falls, Ohio. Attended Lawrence College.

Bernard O. Jankowski, Plant Chemist, Milprint, Inc., West DePere, Wis., a 1942 graduate of St. Norbert College.

John J. Jodrey, Managing Director, Minas Basin Pulp & Power Co. Ltd., Hantsport, N. S., Canada.

Richard A. Kelting, Purchasing Agent, Eastern Div., Uarco, Inc., Deep River, Conn.

Richard H. Koehrmann, Director, International Shoe Co., Plastic Products Laboratory, Wood River, Ill., a 1938 graduate of Massachusetts Institute of Technology.

Bruno A. Koskinen, Senior Research Chemist, Abitibi Power & Paper Co. Ltd., Sault Ste. Marie, Ont., Canada, a 1921 graduate of the Technical University of Finland.

Masatoma Kusunose, Assistant Manager, Toho Rayon

Co. Ltd., Research Institute, Tokushimaken, Japan, a 1937 graduate of Tokyo University.

Donald F. Lehman, Assistant Engineer, Shartle Bros. Machine Div., The Black-Clawson Co., Middletown, Ohio, a 1949 graduate of the University of Dayton.

Hans H. Maier, Mechanical Engineer, Quebec North Shore Paper Co., Baie Comeau, P. Q., Canada, a graduate of German Allgem. Masch. Bauschule.

Julius H. Mappus, Jr., Technical Service Superintendent, West Virginia Pulp & Paper Co., N. Charleston, S. C., a 1948 graduate of North Carolina State College.

David Markowitz, Manager, Product Development Sec., Koppers Co., Inc., Pittsburgh, Pa., a 1947 graduate of Brooklyn Polytechnic Institute.

Paul C. Miller, Vice-President, The Herbert Chemical Co., Cincinnati, Ohio, a 1932 graduate of Capital University.

Thomas Muir, Technical Director, Bone Brothers Ltd., Alperton, Wembley, England.

Harry S. Myers, Chemist, The Borden Co., Chemical Div., Peabody, Mass., a 1944 graduate of McGill University.

Donald C. Newton, Research Assistant, St. Regis, Paper Co., Bag Div., Pensacola, Fla., a 1951 graduate of Lawrence College.

Leslie J. Newton, Director of Research and Development, Building Products Ltd., Montreal, P. Q., Canada, a 1936 graduate of Queen's University.

Willy R. Noiset, Chemist, Robert Gair Co., Inc., Uncasville, Conn., a 1947 graduate of the Institu St. Marie.

Lawrence E. Noll, Sales Engineer, Booty Resineers, Inc., Newark, Ohio. Attended Cornell University and the University of Rochester.

Sigmund Obchon, Engineer, Carborundum Co., Coated Products Div., Niagara Falls, N. Y., a 1952 graduate of the University of Buffalo.

Jean P. Ouderkirk, Librarian, E. I. du Pont de Nemours & Co., Inc., Buffalo, N. Y., a 1945 graduate of Geneseo State Teachers' College.

Lawrence B. Owen, General Manager, Cia. Industrial Commercial del Sur, S. A., Montivedio, Uruguay.

Edmundo Paul, Assistant Technical Manager, Celulosa Argentina S. A., Buenos Aires, Argentina, a 1944 graduate of the University of Buenos Aires.

Ray Pinard, Chemical Engineer, St. Lawrence Corp., E. Angus, P. Q., Canada. Degrees from McGill University and Laval University.

Fred E. Pollock, Chemical Engineer, The Buckeye Cotton Oil Co., Memphis, Tenn., a 1925 graduate of Vanderbilt University.

Richard F. Powell, Vice-President and General Manager, Standard Chemical Ltd., Montreal, P. Q., Canada, a 1926 graduate of Upper Canada College.

Billy M. Reaves, Engineer, Sonoco Products Co., Hartsville, S. C., a 1950 graduate of Clemson College.

Rudolf E. Schmut, Scientific Assistant, Institute of Pulp and Paper Technology, Graz, Austria, a 1952 graduate of Western Michigan College.

Leonard Shapiro, Director of Sales-Service, Borden Co., Chemical Div., Peabody, Mass., a 1934 graduate of Massachusetts Institute of Technology.

Robert H. Smythe, Sales Engineer, Ray Smythe Co., Portland, Ore., a 1950 graduate of Oregon State University.

Gordon E. Stephen, Branch Manager, Ross Engineering of Canada Ltd., Port Arthur, Ont., Canada. Attended Sir George Williams College.

Edward J. Stevens, Irvington Varnish & Insulator Div., Minnesota Mining & Manufacturing Co., Newark, N. J., a 1941 graduate of the College of the City of New York.

Charles R. Stones, Chief Engineer, William Kennedy & Sons Ltd., Owen Sound, Ont., Canada, a 1929 graduate of Bolton Technical College.

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In a book paper mill having the usual loading of felts, plus frequent color changes, acid cleaning of felts was the accepted method. But they got about 50% cleaning, and had time trouble on color changes. Magnus Acidex was tried out and a technique of application developed for their felts. Now they get as close to 100% cleaning as is possible, and they can change colors in an hour and a half instead of the half-day it formerly required.

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but it will take a bit of experimenting to find out which Magnus Felt Cleaner is best suited to your job. Call us in for consultation.

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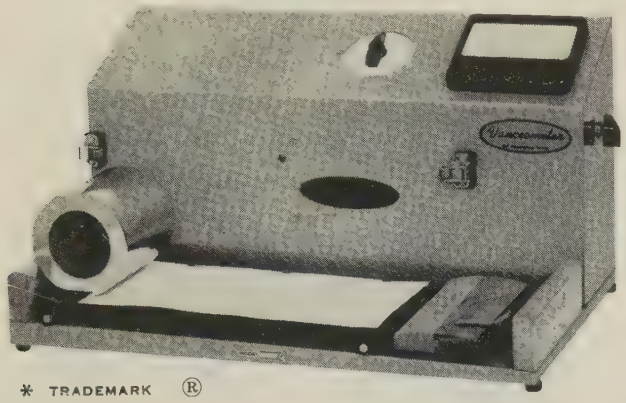

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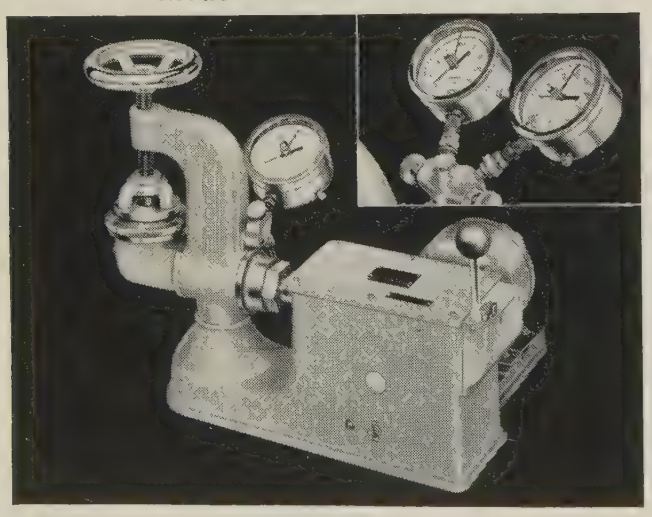

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PACKERS and SHIPPERS—To insure adequate containers for shipping their products.

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zer, Inc., Elizabeth, N. J., a 1953 graduate of the College of the City of New York.

Thomas O. Sweatt, Partner, Carlson & Sweatt, New York, N. Y., a 1931 graduate of Iowa State College.

Leopold Van Raalte, Sales Manager, Van Man, Inc., Brooklyn, N. Y., a 1926 graduate of the College of the City of New York.

Thomas B. Webster, Assistant Mill Engineer, Donnacona Paper Co. Ltd., Donnacona, P. Q., Canada, a 1944 graduate of Queen's College.

William C. Walker, Associate Director, National Printing Ink Research Institute, Lehigh University, Bethlehem, Pa., a 1946 graduate of Lehigh University with a Ph.D. degree.

TAPPI Notes

Lester R. Beeman, formerly Student at Western Michigan College, is now Development Chemist for the Ohio Boxboard Co., Rittman, Ohio.

H. H. Bock, formerly of Parsons & Whittemore Co., is now Associate Technical Director for S. Talaus & Cia, Ltd., Sao Paulo, Brazil.

Richard L. Bradford, formerly of the MacSimBar Paper Co., is now Electrical Engineer for Fibreboard Products, Inc., Stockton, Calif.

Lawrence V. Burton, formerly of the Packaging Institute, is now Technical Consultant, Cragswold, Garth Road, Scarsdale, N. Y.

James H. Clark, formerly of the Solvay Process Div., is now Chemical Engineer for the Diamond Alkali Co., Painesville, Ohio.

Charles H. Claypool, formerly Sulphite Superintendent for the Oxford Paper Co., is now Mill Manager of the Oxford Miami Paper Co., West Carrollton, Ohio.

Harry B. Conner is now General Superintendent of the Oxford Paper Co., Rumford, Me.

J. W. Corriston of E. J. Lavine & Co. has moved his office to 3 Penn Center Plaza, Philadelphia, Pa.

Ernest C. Cowell, formerly Student at Western Michigan College, is now with the Gardner Board & Carton Co., Middletown, Ohio.

H. Lance Crosby, formerly of Rayonier, Inc., is now with Dorr-Oliver Co., Stamford, Conn.

Victor A. Denslow, formerly of the Cities Service Oil Co., is now Senior Salesman for the Spencer Chemical Co., Western Springs, Ill.

Thomas E. Flanagan, formerly of KVP Co. of Canada, is now Chemist for KVP Co., Kalamazoo, Mich.

Wilbur F. Gillespie is now Assistant Manager of the Gaylord Container Corp., Bogalusa, La.

Robert Gordon of the National Gypsum Co. has been transferred from Garwood, N. J., to Newburgh, N. Y., as Maintenance Engineer.

John J. Goss is now Technical Director of the Gaylord Container Corp., Bogalusa, La.

Samuel S. Gutkin, formerly of Falk & Co., is now Sales Manager of Cargill, Inc., Wyazata, Minn.

Warren E. Hesler, formerly of Swenson Evaporator Co., is now District Manager of the Rodney Hunt Machine Co., Orange, Mass.

Ernest R. Hess, Jr., formerly of the Kleistone Rubber Co., is now with Northern Chemical Industries, Searsport, Me.

William T. Hill of Wm. T. Hill Engineering Service has moved his offices from Hoosick Falls, N. Y., to Dalton, Mass.

John G. Hoad, of John G. Hoad & Associates, has moved his offices from Ann Arbor, Mich, to Ypsilanti, Mich.

Walter W. Holland, formerly of the Oxford Paper Co., is now Vice-President and General Manager of British Columbia Forest Products, Ltd., Vancouver, B. C.

E. Langford Jones is now Director of Sales for the Hercules Powder Co., Wilmington, Del.

Gary W. Jones, formerly of Consolidated Water Power & Paper Co., is now in the Research Department of the Weyerhaeuser Timber Co., Pulp Div., Longview, Wash.

Ralph M. Leighton is now Technical Service Manager for Stowe-Woodward, Inc., Newton Upper Falls, Mass.

Erhard H. Lenz, formerly Student at the University of Maine, is now in the Production and Technical Control Department of Fea. Papel Lorets y Pena Pobre S/A, Mexico, D. F.

William D. MacKinnon is now Manager of the Board & Insulation Div., Donnacona Paper Co., Donnacona, P. Q.

Donald J. MacLaurin, formerly of The Institute of Paper Chemistry, is now Technical Director of the Gilbert Paper Co., Menasha, Wis.

George D. McTeague, formerly of Cia. Ind. de Papel Pirahy, is now Training Officer in the Export Personnel Dept. of Brown & Williamson Tobacco Co., Louisville Ky.

Richard L. Maeder, formerly of Donnacona Paper Co., is now Sales Representative for Porritts & Spencer of Canada, Ltd., Hamilton, Ont.

George W. Mead, II is now Assistant Production Manager of the Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

John G. Meiler, formerly of the Coos Bay Lumber Co., is now a Consultant, P. O. Box 805, Tacoma, Wash.

Walter B. Morehouse is now Assistant Vice-President and General Sales Manager of the Nopco Chemical Co., Harrison, N. J.

Harry S. Myers, Chemist for the Chemical Div., Borden Co., has been transferred from Peabody, Mass., to Chicago, Ill.

P. A. Nussbaumer of the Pollock Paper Co. has been transferred from Middletown, Ohio, to Dallas, Tex., as Chief Chemist.

Leslie A. Palmer is now Vice-President and General Manager of the Donnacona Paper Co., Donnacona, P. Q.

Robert W. Pattison, formerly of the Adell Chemical Co., is now Technical Sales Director of the Pulp and Paper Chemicals Div. of the Berkshire Color & Chemical Corp., Springfield, Mass.

Robert R. Peck, formerly of the Oxford Paper Co., is now Technical Adviser, Army Chemical Corps, T.V.A. Phosphate Development Works, Sheffield, Ala.

Ardell S. Peterson, formerly of the Marinette Paper Co., is now Process Control Engineer for the Scott Paper Co., Detroit, Mich.

Harry P. Petzold, formerly of the Oxford Miami Paper Co., is now Mill Manager of the Oxford Paper Co., Rumford, Me.

Frank E. Safino, Jr., formerly of the Lowe Paper Co., is now Project Engineer for Colgate Palmolive Co., Jersey City, N. J.

Richard L. Savage, formerly of the St. Regis Paper Co., is now Coating Chemist for Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

Karl J. Schueppert, formerly of the Rhinelander Paper Co., is now Process Engineer for the Rheem Mfg. Co., Chicago, Ill.

Michael Shenk, formerly with Adhesives Resistol, is now Research Chemist for Dilco Products, Inc., Redwood City, Calif.

George E. Shipman is now Manager of the Pulp and Paper Div. of the Donnacona Paper Co., Donnacona, P. Q.

Douglas W. Shook, formerly with Kimberly-Clark Corp., is now Personnel Superintendent of Berkeley Mill, Inc., Balfour, N. C.

Bernard F. Sobel, formerly of Peter J. Schweitzer, Inc., is now mathematician for the Ethyl Corp., Baton Rouge, La.

Cheng M. Sun is now Factory Manager of Kiu Dah Pulp & Paper Co., Taipei, Taiwan, China.

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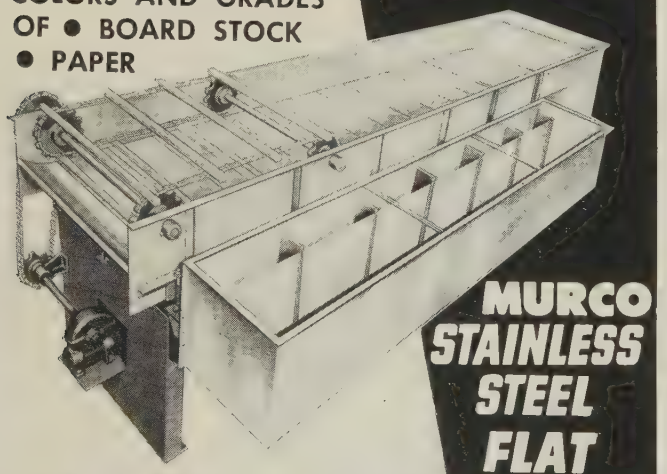

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Alfred Suter is now Manager of the Gaylord Container Corp., Bogalusa, La.

Arthur L. Taylor is now General Manager of the Bermico Div., Brown Co., Boston, Mass.

C. Edward Taylor, formerly of the Crown Zellerbach Corp., is now Technical Assistant to the Pulp Mill Superintendent, St. Helens Paper Co., St. Helens, Ore.

W. L. Thompson, formerly of Mid-Continent Petroleum Corp., is now Assistant Director of Research and Development for the D-X Sunray Oil Co., Tulsa, Okla.

Kaare Ulsteen, formerly of Norsk Spraengstofindustri is now with Nitroglyserinkompaniet, Saetre i Hurum, Norway.

Vincent H. Urquhart of the National Container Corp. has been transferred from Aurora, Ind., to Long Island City, N. Y., as Plant Manager.

Geza J. Vayda, formerly with Klabin de Parana de Cellulosa S/A, is now Resident Manager of the Stone Container Co., Franklin, Ohio.

Douglas M. Wallace is now Management Apprentice for the S. D. Warren Co., Cumberland Mills, Me.

V. Edmund Ware, formerly of Doeskin Products, Inc., is now engineer for the Warren Steam Pump Co., West Brookfield, Mass.

Nils V. Wegner, formerly of Sandvikens Pulp Co., is now Manager of Otterbackens Bruk, Porla, Sweden.

John P. Weidner of the Container Corp. of America has been transferred from Manayunk, Pa., to Chicago, Ill., as Assistant Technical Director.

* * *

Freeman Perry has succeeded *R. A. Diehm* as the official corporate representative of the Ward Paper Co., Merrill, Wis., in TAPPI.

The Technical Section of the Canadian Pulp & Paper Association is now located at 2280 Sun Life Bldg., Montreal 2, P. Q.

* * *

Norman L. Kehali has succeeded *Allen G. Griswold* as the official representative of the Cities Service Oil Co. in TAPPI.

Frank F. Elliott has been elected President of the Crane Co., Chicago, Ill.

The Pennsylvania Salt Mfg. Co. has moved its offices from the Widener Bldg. to Three Penn Center Plaza, Philadelphia, Pa.

Industry Notes

PRODUCTION

In April the unprecedented demand for paper and paperboard experienced during the first quarter of the year continued unabated. As a result, mills ran at close to their capacity levels to produce an estimated 2,457,000 tons. This was about 5% less than in March, due chiefly to there being one less working day, but 5% more than in April, 1951, when the previous high for the month was established.

Normally production during the second quarter is somewhat greater than that for the first three months and, with the momentum carrying through April, a production in excess of 14 million tons is indicated for the first six months.

The April output of printing papers, at 328,000 tons, was about 4% less than in March, but 8% greater than that of April, 1954. For the year to date production of these papers was approximately 1.3 million tons, 5% more than for the same period last year. The volume of new orders received during the month was 6% less than in March, and shipments were equal to production. As a result, the backlog of orders unshipped decreased to 384,000 tons, equal to about 31 days' production at the current rate of operation.

Fine paper production continued strong, as mills making

these grades produced 128,000 tons, approximating the March output of 129,000 tons. The tonnage represented by new orders received in the course of the month again exceeded the quantity shipped, causing the backlog of mill orders to rise further to an estimated 86,000 tons. This was equal to about 17 days' production.

The production of coarse paper continued at a high rate during April as 318,000 tons were manufactured. Although this was about 3% less than was recorded for March, it was almost 15% more than the output achieved in April, 1954. As a result, the relative improvement over last year to date continued its rise to almost 8%. The volume of new orders received continued to run in excess of shipments, with the consequence that the tonnage represented by unshipped orders increased to 177,000 tons, equal to 27 days' production.

The production of tissue paper is estimated to have been 139,000 tons. Thus, barring a subsequent revision, the output of these papers for the first time failed to exceed the output for the same month last year. It should be noted, however, that in 1954 April production reached its high point for the year and, despite the relative decrease for the latest month, output for the first four months represents a gain of 2% over the comparable period in 1954.

Producers of newsprint continued to step up their production, with the result that production rose to 121,000 tons, 30% greater than in April, 1954. Output for the year to date, 459,000 tons, was 24% greater than at the same time last year.

Paperboard production decreased by about 6% from that attained in March, as an estimated 1,111,000 tons were manufactured. The volume of unfilled orders continued to increase in the course of the month and at its close amounted to an estimated 494,000 tons.

The highest levels ever recorded in the production and consumption of pulp, paper, board, and converted products were achieved by the domestic industry during the first 5 months of 1955, according to trade association current statistics. Actual first quarter production of paper and board, as reported by Census, was 10% over the same period of 1954.

The velocity of activity in the industry so far in 1955 is closely related to the Nation's growing purchasing power. Personal disposable income, after taxes, during the first quarter of 1955 was at an annual rate of $261 billion dollars compared with $252 billion a year ago. Also especially significant to the paper, board, and converted products industry is the steady rise, over the past 8 months, of the Federal Reserve Board adjusted index of nondurable production, which has increased from 114 in August, 1954, to 124 by April this year.

Major gains are being recorded this year, compared with a year ago, in every grade group of paper and board. It is evident that in all important areas of use such as printing and publishing, packaging, sanitation, industrial applications, and building and construction, consumption has increased materially over the first part of 1954. There is no evidence of significant inventory accumulation of paper or board in converting or distributing channels. Equally noteworthy—the Nation's total business inventory during the first three months of 1955 remained practically steady. The high and rising level of durable and nondurable sales has been largely parallel to production of goods so that there has been no opportunity to accumulate inventories in most lines, even if desired.

In the past five years world paper and board production has increased approximately 20%, based on estimates made on the increase in production in this period in the 12 leading paper and board manufacturing countries of the world. Production in North America increased 12.3% and constituted 62% of the world's production in 1954, the same as in 1950. Europe, as represented by the nine leading producer countries, showed an increase of 35% and accounted for 27% of world production. Japan, the leading producer in the Far East, increased its production 122% in the past five years, with a

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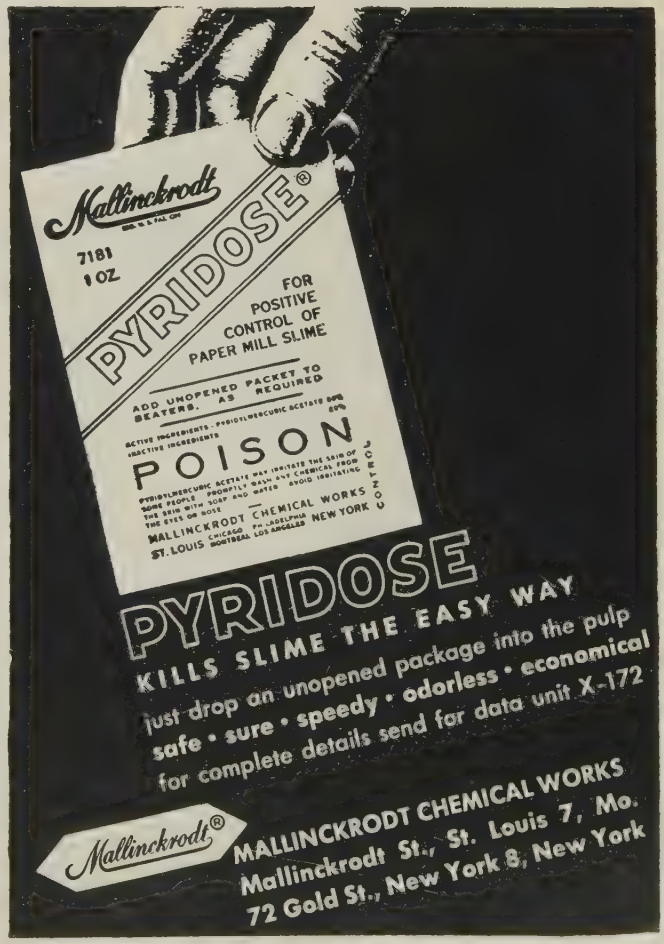
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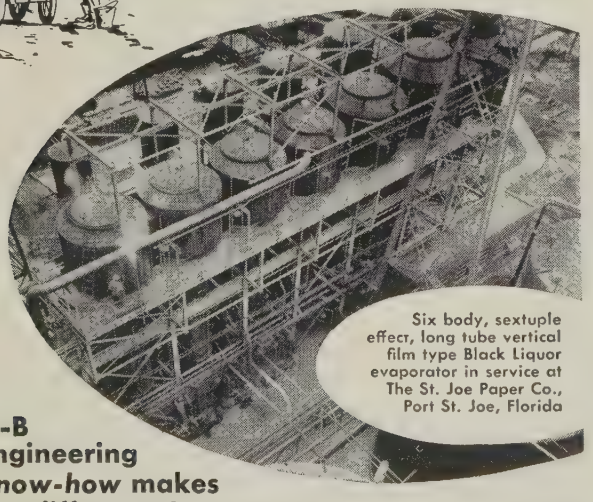

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production representing approximately 4% of world production last year.

The twelve leading paper and board manufacturing countries of the world as listed on the table represented 83% of the total production in 1950, the same percentage applying for 1954. The remaining 17% increase includes new or additional facilities placed in operation in Europe, Latin America, Africa, the Near East, Asia, and Australia.

Not only do these 12 countries represent the major portion of world production, but the imports and exports of paper and board of these countries constitutes a significant portion of world trade in these products. It is interesting to note that in some instances exports have declined for several countries in this five-year period, and in each case where this has occurred, imports have increased appreciably. This is indicative of the growing demand for paper in those countries which cannot be met in all cases with existing production facilities.

The rise in consumption of paper in the past five years is especially noteworthy, and in all but one instance, where a small decline was indicated, the increase in each of these countries has been significant. In the case of Japan, consumption has more than doubled, and in Russia and Sweden, has come close to doubling in this relatively short period of time. In 1950 these twelve represented 90% of the world's apparent paper consumption of 47,000,000 tons, and in 1954 this consumption totaled slightly over 50,000,000 tons. On the basis of this relationship, apparent world consumption last year may be estimated at approximately 56,000,000 tons, representing an increase of 9,000,000 tons since 1950.

Pulpwood

First quarter pulpwood receipts were 8,159,000 cords, an increase of 1,088,000 cords above the first quarter of 1954. Of this increase, domestic receipts accounted for 1,029,000 cords and imports for 59,000 cords.

Pulpwood consumption increased 1,002,000 cords in the first quarter, averaging 343,000 cords a month above the monthly average for the first quarter of last year.

Inventories at the end of March were 5,347,000 cords, 216,000 cords below February and 324,000 cords less than March, 1954.

Wood Pulp

Wood pulp production in March reached a record high of 1,738,000 tons, and for the first quarter, 5,003,000 tons were produced. This was an increase of 596,000 tons over the first quarter of 1954.

Continuing high paper and board production was evidenced in the record-high wood pulp consumption for March of 1,839,000 tons. For the first quarter, 5,157,000 tons of pulp were consumed, an increase of 534,000 tons above the comparable quarter of 1954.

First quarter imports of wood pulp amounted to 517,502 tons, an increase of 22,098 tons above the first quarter of last year. Imports from Canada increased 23,173 tons, while overseas imports declined a moderate 1075 tons. Imports from Sweden and Norway declined 7267 tons and 2106 tons, respectively, while those from Finland increased 8326 tons.

Continuing high exports were reported for March and by the end of the first quarter shipments abroad amounted to 166,600 tons, an increase of 105,000 tons above shipments for the comparable first quarter of last year.

Inventories at the end of March were 654,000 tons, a decline of 4000 tons under February and 10,000 tons under inventories at the end of March, 1954. Pulp mill inventories at the end of March were 156,000 tons and at paper and board mills totaled 498,000 tons.

Newspaper Outlook

The following article was excerpted by the Newsprint

Service Bureau, New York, N. Y., from the June 6, 1955, issue of *Advertising Age*.

If any one thing characterized the newspaper business as it hit the halfway mark of 1955, it was a posture of defense. In some aspects, the posture bristled with defiance; in others, it was coupled with aggressive attack. In some, it was tinged with outrage.

First in the minds of many newspaper publishers was their concern over the government's attitude toward newspapers. They were studying the signs, and they didn't like what they saw—a government anti-trust suit, with the American Newspaper Publishers Assn. as a primary defendant; the Kansas City *Star* appealing from a lower court decision that it had conspired to monopolize advertising and news; the Lorain *Journal* decision. In addition, there had been the *Times-Picayune* case, which went to the Supreme Court before the government lost, and which carried with it the worried scrutiny of every publisher operating a forced combination.

Further, there was the problem of the Federal Communications Commission. In the McClatchy Newspapers Case, FCC had indicated that operators other than newspapers were the most desirable licensees for television grants. Many newspapers were already in the television business; others would like to be. Still more had been in the radio broadcasting business for years. And if the record of their stewardship was unsatisfactory to FCC or to anyone else, there were no license revocations in evidence.

And there were other annoyances, major and minor: there was a good chance that the Treasury Department might withdraw the income reserve provision in the 1953 tax law—a revocation which would be a severe blow to publishers. Newsprint was expensive, though in adequate supply, but United States usage was rising, and overseas consumption was expected to go up. The Post Office had bowed under a drumfire of junk mail, but the way it handled second class, and the way it set costs in that dubious area, were still not to publishers' liking. And the long, grinding battle against government overclassification and use of the "security" mantle to hide ineptitude and fraud also were publishing irritants.

Advertising has been a long succession of crescendos for newspapers in the postwar years, with record following record and impressive gains up and down the line of classifications.

But in 1954 the script slipped: total national revenue dropped from 1953's all-time high of $601,224,000 to $594,120,000. The losses were spread across the board, and although 1954 was disappointing it was still the second biggest newspaper year on record.

The newspaper business in recent years has talked tough about magazines and television, but last year it really began to take off the gloves. The Chicago *Tribune's* anti-television presentation not only slugged savagely at audience statistics but dwelt lovingly on share-of-market losses of companies which had abandoned newspapers to dance in the light of the magic lantern medium.

A few years ago, the big news on the newspaper scene was the teletypesetter. There are now 1120 newspapers, including 793 United States dailies, using teletypesetter service and Teletypesetter Corp. has invented an automatic allocating machine which enables operators to feed tape to any of several high-speed linecasting machines, so that all are operating efficiently.

Significantly, newspapers are far more willing to test new equipment than they were a few years ago, and the results of the tests by those willing to experiment have been beneficial to the whole field.

Five years ago, r.o.p. color was making significant progress in the newspaper field. Today there are about 613 United States newspapers equipped to handle two or more r.o.p. colors.

This year the American Newspaper Publishers Assn.-American Assn. of Advertising Agencies settled on a standardized lineup of three process colors, nine mixing and blend-

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2. Practically every machine built in recent years has an FDD system.
3. Older and smaller mills are also rapidly installing FDD.
4. FDD will step up any dryer section—assure uniformly graduated temperatures under automatic control and make for faster, more uniform drying.
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Drop us a line for particulars. You're really missing a bet if you don't.

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DAYTON, OHIO

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ing colors and a mixing and blending white. Known as the ANPA-AAAA standard r.o.p. colors, these will be available from all ink manufacturers in the near future.

Where the posture of defense is tinged with outrage is in the area of labor, unions and strikes. Early this year, in January, the Brooklyn *Eagle* was struck by the American Newspaper Guild. After several weeks of negotiation, the publisher, Frank Schroth, announced his decision to close the *Eagle* permanently and it was sold piecemeal at auction in May.

He objected to a union scale which put the *Eagle* on a par with larger New York dailies, and he pointed out that "the *Eagle* is No. 8 in top salaries paid to Guild employees. The union position was that the *Eagle* was paying the going New York wage to mechanical unions and ought to pay it for editorial and clerical help.

The early postwar years were blotched with strikes in the newspaper business, reaching a high in 1947 with 40 strikes, of which 31 were those of the International Typographical Union. But in those strikes, publishers generally managed to keep going.

In 1950, however, the Guild strike brought the New York *World-Telegram & Sun* to a halt with a strike in which the mechanical unions refused to cross the Guild picket lines. The same technique worked in the Seattle *Times* strike in 1953 and the 1954 strike against the Wilkes-Barre newspapers. In Brooklyn, adopting a now-familiar attitude, the mechanical unions wouldn't cross the Guild line.

Despite the periodic moans of publishers that the profit has gone out of the newspaper business, and despite the undeniable fact that there are fewer metropolitan newspapers published in the United States than there were a few years ago—newspaper values continue to stay high.

Last year the St. Louis *Globe-Democrat* changed hands for $7,750,000, and early this year the Toronto *Globe & Mail* was sold to R. Howard Webster for $10,800,000. Those prices sent a low whistle through other branches of the publishing business.

As newspapers swept through the first quarter, it was evident that 1955 showed every promise of being a much better year than 1954. In the first three months, based on a Bureau of Advertising check for 110 cities, national advertising was up 8.1% over the previous year.

The big dollar categories were passenger cars (up 26.4%), gas and oils (up 15.1%), and the grocery classification. Grocery ads, which accounted for around 22% of all newspaper national advertising in the first quarter, were up 4.7%—a little less than $2,000,000.

There is some evidence that the major increases logged so far in 1955 are among the larger papers, many of which are up substantially in national linage—as the Media Records 52-city report attests. In the smaller cities, linage is on the rise, but the first quarter was nowhere near as spectacular as for their more affluent metropolitan counterparts.

Despite television, competitive print media, and aroused government interest in their business, it looked as if 1955 would be a tremendous year for newspapers.

Wastepaper

Recently, at a National Association of Waste Material Dealers Atlantic Division meeting in Buffalo, Haskell Stovroff, NAWMD president, made some pointed remarks to the wastepaper dealers present at the meeting. The wastepaper trade, he said, should do well this year, for the paper industry is booming, and the mills will probably consume more wastepaper this year than any year in history. If anyone is not doing well, he added, then he should re-examine his operations and find out what is wrong, for conditions will rarely be more favorable than they are now.

Just how favorable are the conditions?

Well, in the words of one spokesman for a big paper company: "If anyone but a regular customer came to us and asked for a carload of paper, we'd tell him to take a running jump." The paper industry, the fifth largest in the nation, after having expanded its capacity by 43% since the end of World War II, is finding that the Nation's appetite for paper is more than it can keep up with. The outlook is for a continued strain on the mills' capacity and further price increases on paper, board, and newsprint. One mill has already said it will take the bare minimum of days—no more than three or four—for its traditional July shutdown. The evidence is that the mills expect the heavy demand to continue through the remainder of the year.

The facts are self-evident. If mills are going to produce more paper, then they are going to need more wastepaper—unless something better comes along. It is up to the wastepaper trade to see that the commodity it handles is so attractive both as to quality and price that nothing better will come along.

Mill purchasing agents are notorious skeptics. When they see a lineup of trucks delivering wastepaper to their plants they cannot be convinced that wastepaper is scarce. They also can see no reason for increasing their buying prices when stock is available to them when they want it. Finally, while the great majority of mill shippers of wastepaper are reputable business men, some will always try to get away with something in the way of quality or weight. The purchasing agents do not pat the reliable shippers on the back; nor do they need to, for specification packing is something they have a reason to expect. However, they do remember the bad shippers, and it is these dealers who can destroy the wastepaper trade.

Every shipper must endeavor to send the mills the best stock available. Shipping a mill stock that is bound to be rejected weakens the dealer's own case. A scarcity occurs when dealers find that what the mills want is not available and the mill cannot get what it requires. The answer does not lie in shipping stock that the mill cannot use.

The trade also faces a problem on the buying end. Wastepaper packers simply cannot conduct their buying operations at a loss and expect the mills to bail them out by paying higher prices. Lack of attention to costs is perhaps the greatest failing among the many packers who are today complaining of poor business conditions. The trade must remember that mills will pay more for wastepaper only when they cannot get what they want at present prices.

No one, of course, can say how long the present boom in paper will continue. Good times and bad times come in cycles. But Haskell Stovroff is right. Dealers who cannot operate profitably when business is good had better change their ways of doing business or soon enough they won't have any business to worry about.

Reprinted from *Daily Mill Stock Reporter*, June 9, 1955

Spent Sulphite Liquor Utilization

A major "break" in the drive to find ways of using the millions of gallons of waste liquor which pour down the drains in Canada's pulp and paper mills was revealed recently.

It's a revolutionary new process, developed over a three-year period at the laboratories of the Pulp & Paper Research Institute of Canada. Using equipment of simple design, said W. H. Gauvin, of McGill and the institute, sulphite spent liquors, in particular, can be processed quickly through a series of physical operations and chemical reactions to yield some 70% of the sulphur originally present, plus other materials of potential value.

More than 90 test runs have been conducted in a 10-ft. high model unit at the institute's labs, and the process is believed commercially feasible. It may have wide application to other chemical processing industries in which there may be even more commercially profitable applications than have yet been suggested for pulp and paper, Mr. Gauvin remarked.

The new technique features the atomization under pressure of the waste fluids in a specially built chamber, and may eliminate the former evaporation and drying processes which

are time-consuming and expensive. Some sulphite spent liquor from chemical pulping operations is used these days. But most of it goes down the drain, carrying with it around half the volume of the original logs. In that liquor are sulphur, sugars, and a whole range of useful chemicals in complex mixtures. It's even felt by some authorities that the total value of the products in it is greater than the value of the pulp itself.

Recovery of 70% of the sulphur originally used is a major step. Two years ago, it was felt that 40% could be recovered, and even that was considered a first-rate achievement.

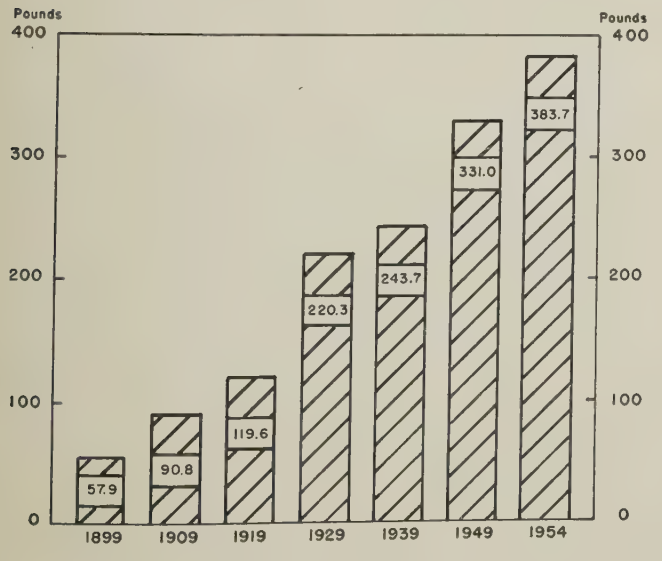
Paper Industry Growth

If one word could characterize the history of our country over the past 50 years, that word might well be "growth." For over that period, we have as a nation grown to world leadership and responsibility to an extent then difficult to imagine; our population has more than doubled; and, the material comforts of living have increased to an immeasurable degree.

Those who work at one of the many and varied tasks in the manufacture of paper know something about what it takes to improve the quality and comfort of our daily living constantly because, from the moment the woodsman's axe bites deep into a tree until the finished paper rolls out of the mill, they have participated in producing a material which to a substantial degree has made this nation's high standard of living possible. They have the inner satisfaction that comes from knowing their work is important and that they are associated with an industry having a great potential growth.

The modern paper industry had its beginning at about the turn of the 20th century when techniques for preparing wood pulp were developed. This more than anything else since the invention of the fourdrinier machine has made possible the mass production of a relatively low-priced media for printing and packaging—uses for which the bulk of paper is produced.

Since 1900, the growth of this country's production of paper—although interrupted occasionally by war and depression—has been remarkably constant as it rose from about 2 million to almost 27 million tons. This rise in output is not only explained by the fact that our population has greatly increased. For if this were the only factor involved, our production this past year would have been less than 5 million tons. The phenomenal increase has been possible only because the growing population has been productively and profitably employed by industry operating in a freely competitive economic system.



Paper and board consumption per capita

The growth of our printing and publishing industry, as literacy and leisure time increased and business learned that "it pays to advertise," has stimulated the production of our so-called cultural papers.

In the paperboard segment of the industry, large and rapid growth has been experienced as the economies inherent in the use of strong, lightweight paperboard containers for shipping have been recognized and seized upon by alert manufacturers ever seeking to increase the efficiency of their methods of distribution. Paperboard containers are now used to package a wide variety of products from pills to bathtubs, including numerous items, such as lettuce and lemons, which until recently were considered impossible to transport in anything but the traditional wooden container. Moreover, the steady trend toward self-service stores has greatly stimulated package engineering and design. In today's store, the container is in effect a silent salesman which by its own appeal must attract the customer to the contents and subtly influence his selection.

The result has been that from the beginning of this century to the present, per capita consumption has risen from 58 to 390 lb. until this country, having about 6% of the world's population, uses almost 60% of the paper produced throughout the world. Most important, the limits of growth have not been reached for at this very moment researchers are working to develop new qualities and grades of paper to further broaden the market for this industry's products and further increase the industry's contribution to the welfare of the Nation.

—from *Forest Echoes*, April, 1955.

Canada

The Canadian pulp and paper industry is one of the major industrial enterprises of the world. Canada is the greatest exporter of pulp and paper in the world. More than four fifths of the total output moves abroad. Some 93% of her newsprint production is exported and 95% of the pulp manufactured for sale also goes to foreign markets.

There are 78 pulp and paper companies operating 130 mills in eight provinces. Their output is one third greater than that of all the Scandinavian countries combined. Almost one third of the wood fiber requirements of the United States, the largest pulp and paper producer in the world, comes from Canada which exports annually to the United States 1.8 million cords of pulpwood; 1.7 million tons of pulp; and 5 million tons of newsprint, close to 2 million tons of which are eventually repulped and made into paperboard or other products.

The Canadian industry has a total annual output of some 10 million tons including 2.3 million tons of pulp for sale; six million tons of newsprint; and 1.6 million tons of other papers, paperboard, and building papers and boards. Of the total pulp and paper output, 46% comes from Quebec, 26% from Ontario, 12% from British Columbia, and 16% from the four Atlantic provinces.

The mills expend annually some $12 million on fundamental and applied research and on development work in forest and mill aimed at producing more and better products from every cord of wood and more wood from every forest acre.

Pulp and paper markets everywhere are widening. In North America, the population is increasing by 3 million a year, or the equivalent of adding three great cities—Minneapolis, Buffalo, and Cincinnati—annually to the population. Elsewhere, increasing industrialization and increasing literacy are stimulating the demand. Amidst the free nations, Canada has the last large coniferous forests capable of substantially increased production. The world must look to Canada for increasing supplies of pulp and paper.

The 70,000 pulp and paper people permanently employed in the mills, woods, and auxiliary services are among the highest paid workers in industry.

Pulp and paper is truly the national industry of Canada, standing first in employment, in total wages paid, in export values, in value of production, and first in capital invested. The welfare of all Canadians depends on the well-being of this great national industry.

With an annual value of production of $1.2 billion, pulp and paper accounts for 7% of the value of the output of all Canadian industry. Canada's output of pulp and paper exceeds in value the total annual production of wheat and all other grains combined; it equals the national annual mineral production including previous metals, base metals, iron ore, petroleum, asbestos, and coal; and it is half again as great as the value of the automobile industry's output. Pulp and paper is Canada's one outstanding industry.

Pulp and paper exports are worth $925 million annually to Canada. They account for 33% of the value of exports to the United States and for 24% of all exports. Every Canadian has a stake in the maintenance of these markets. In value, Canada's pulp and paper exports far exceed exports of all agricultural and vegetable products combined, including grain, flour, and liquor. They are far greater than exports of nonferrous metals and their products. They are three times as great as exports of all animal and animal products, and three times as great, also, as exports of iron and its products, including autos and agricultural machinery.

The 20% of the output of the industry that is made for consumption at home would alone make the industry a leader in Canadian trade. The domestic market for pulp, paper, and paperboard amounts annually to some $290 million, a figure half again as great as Canada's gold production.

Even excluding its seasonal woods workers, pulp and paper is by far the largest industrial employer in the land. The employment the industry provides in the woods runs counter to the normal seasonal pattern. In the late autumn and winter when employment elsewhere is at its lowest ebb, pulp and paper provides work in the forests for more than 200,000 Canadians. Thus, the industry helps to stabilize employment. The industry's wage bill approximates the combined wages paid by the three industries that, after pulp and paper, rank as the largest industrial employers.

Based on the replacement value of the mills, the pulp and paper industry represents an investment of $40,000 for each mill employee. Pulp and paper is the largest industrial buyer of goods and services in Canada. Annually it pays out $400 million in wages, $200 million for transportation, $200 million for supplies and electricity, and $100 million for purchases of pulpwood.

Of the industry's annual wage bill of $400 million, about 60% goes to mill workers and the remainder to woods workers. No single industry pays more. No industry has a better labor-management record.

Pulp and paper has been largely responsible for making Canada the second largest hydroelectric power producer in the world. The mills use a quarter of the total consumption of electricity in Canada, and one third of the power used by all industry.

Canada accounts for a third of all international trade in pulp, the raw material of paper and paperboard and also of rayon, photofilm, paints and lacquers, explosives, artificial sponges, plastics, cellophane, and a variety of other products of the chemical and other industries.

Four fifths of the Canadian wood pulp output is manufactured in mills that convert it immediately into paper, paperboard, building board, and other products. The remainder is sold as pulp.

The mills produce annually more than 2 million tons of pulp for sale of which 5% is used in Canada. Thus pulp exports of some $300 million annually are a chief item in Canada's export trade and rank only after exports of newsprint, lumber, and wheat.

Newsprint accounts for 60% of the total tonnage produced for sale by the mills; pulp for sale for 23%; paperboard for 10%; and fine, tissue, wrapping, construction, and all other papers for 7%.

In newsprint paper, Canada has a production four times that of any other country and provides more than half the world's supply. Some 93% of the newsprint output is exported.

Netherlands Straw Utilization and Research

In the Netherlands about 500,000 ha. of cereals are grown, chiefly rye, wheat, oats, and barley. On the average the straw yield of this acreage amounts to 1,800,000 kg.-tons.

The larger part of this straw is used for agricultural purposes: bedding and fodder for cattle, soil cover in horticulture, and other purposes. Still, a large quantity always remains available for the industry, viz, about 580,000 kg.-tons, i.e., more than 30% of the production. Nowhere else is such a high percentage of the straw production utilized industrially.

The farms in the province of Groningen (in the North of the country) with their large straw crops have contributed much to the development of the straw-processing industry. The sound agrarian organization in this region, the careful way in which the grain crop is harvested, formerly by hand and now mechanically, and certainly also the methods applied here for pressing and stocking the straw have meant that industry can always count on a regular supply of good quality straw.

The straw producing farmers have also occupied themselves with the processing of straw in cooperative mills. Among the large number of strawboard mills situated in Groningen the cooperatives, owned by the farmers, occupy an important position, both with respect to quantity and quality.

The Straw-Processing Industry. Of the 19 Netherlands strawboard mills 18 are situated in the province of Groningen, as well as two of the three strawpulp mills. Also the wallboard mill in Hoogezand belongs to the large industrial consumers of straw.

However, straw covers and ropes are manufactured exclusively in the southeastern region of the Netherlands.

The capacity of the Netherlands straw-processing industry is divided as follows—

Cardboard (common strawboard and other kinds of board)	450,000 kg.-tons of straw
Pulp (raw material for the paper industry)	95,000 kg.-tons of straw
Wallboard	28,000 kg.-tons of straw
Straw cover and ropes, etc.	10,000 kg.-tons of straw
	583,000 kg.-tons of straw

The production capacity of the industry is approximately as follows—

Cardboard	350,000 kg.-tons
Pulp	40,000 kg.-tons
Wallboard	20,000 kg.-tons
Straw covers, etc.	10,000 kg.-tons

The strawboard, strawpulp, and wallboard industries export an important part of their respective productions. The following figures may give an impression of turnover and export of the strawboard mills: fiscal year 1950–51, turnover of the 19 mills of strawboard and special kinds of board Dfl. 88,000,000; fiscal year 1953–54 turnover of the 19 strawboard mills of strawboard and special kinds of board Dfl. 98,000,000. Exports amounted to two thirds of the turnover, having a value of more than Dfl. 60,000,000, for which inland raw materials were processed by about 4000 workers. This illustrates the great importance of the straw-processing industry to the Netherlands economy.

Research on the Utilization of Straw. The straw-processing industry can now make use of a well-equipped research institute, viz. The Netherlands Experiment Station for the Utilization of Straw. The station comprises a chemical

laboratory where straw and straw products are analyzed, a designing room where the projects are made which are carried out in the station's workshop, equipment for the manufacture of board and paper on a laboratory scale, an air-conditioned room for strength determinations of handsheets and determination of tensile strength of board, and equipment for the manufacture of board and paper on a semicommercial scale.

Results of the Station's work to Date. In the beginning the station's work was limited to the collection of data on the chemical and morphological composition of Netherlands kinds of straw, but soon investigations concerning the manufacture of paper pulp from straw were undertaken, first only on a laboratory scale, later on, after extension of the equipment, also on a semicommercial scale. In this work straw was cooked with both caustic soda and with neutral sulphite. The results of this research were of importance for the extension of the Netherlands strawpulp industry after the war.

Digestions with caustic soda and with neutral sulphite were also applied for the manufacture of strong cardboard from straw which yielded valuable data for the cardboard industry.

During the last few years increasing attention was paid to the manufacture of the lime-cooked strawboard which is the main product of the industry.

Although digestion of straw with milk of lime has been applied now in the Netherlands for about 80 years, and has been known for a much longer time than digestion with either caustic soda or neutral sulphite, the lime process is much less clear than the other two. However, the station has succeeded in obtaining a fair insight into the former process so that fruitful research in this field will now be possible. For this purpose the Society of Netherlands Strawboard Manufacturers created a research group at the Station in the beginning of 1954.

The Station's Present Potentialities. The present equipment enables the station to manufacture both cardboard and bleached pulp from straw and to investigate practically all important properties of these products.

For cooking the straw digesters of 3 and 100-l. capacities are available. In these digesters straw can be treated with solutions of various chemicals at temperatures above 100°C.

A different apparatus for cooking straw is the hydrapulper, in which the action of the chemicals is supported by mechanical action, but the temperature cannot be raised above 100°C.

The cooks obtained can be worked up on a laboratory and on a semicommercial scale to render the fibers suitable for the manufacture of handsheets of paper and board. The paper pulp can be bleached, if necessary. Extensive equipment is available for investigating strength and other properties of these handsheets.

With this equipment the procedure in board and pulp mills can be imitated to a certain extent and, thus, all sorts of investigations on board and pulp manufacture can be carried out.

However, rather large differences still exist between the small handsheets made with a discontinuous sheet forming apparatus and the board or paper made on a continuous mill machine. Therefore, there are a number of aspects of mill procedures which can only be investigated when a continuous experimental board machine is available. For this reason the station has procured such a machine.

As the station has not yet obtained equipment of sufficient capacity to feed its board machine, the necessary stock must be obtained from a mill. A project for purchase and mounting of a rotary digester of 1700-l. capacity and suitable further apparatus is being worked out.

When this project is realized the station will possess equipment with which, if not all, at least the greater majority of the problems which may arise in the manufacture of cardboard and paper pulp from straw can be tackled.

Finland

Under an agreement signed in Moscow, Finland will this year deliver to the U.S.S.R. 73,970 tons of paper and board.

The total includes 10,000 tons of newsprint, 9000 tons of kraft sack paper, and 5000 tons of folding board.

Finland will also deliver paper products worth 5 million roubles, one newsprint machine, nine longitudinal papercutters, five items of fiber recovery equipment, and equipment worth 2 million rubles for manufacturing high quality paper.

Nova Scotia

Officials in Nova Scotia are continuing their efforts to obtain another pulp and paper mill for the province.

Detailed surveys of the province's timber resources have been under way, and Trade & Industry Minister W. T. Dauphinee now states that the Hearst interests are thinking about a much larger operation than was originally considered. Last fall, Hearst was known to be considering spending $10 million on a newsprint mill with a daily capacity of 200 tons at Sheet Harbor, a small community on the eastern shore. It already controls a groundwood mill there.

Mr. Dauphinee indicates that results of the Cape Breton Island forest survey have been handed over to a Canadian-British group with whom negotiations were under way in 1953. And they have also been passed along to other interests.

Tentative proposals have been made to the government, but it will be some time yet before any negotiations are finished.

North Carolina

The General Assembly has passed legislation permitting rapid amortization for waste treatment plants to encourage stream pollution abatement. The new law covering state income and franchise taxes, allows 5-year amortization of waste treatment plants, but leaves it up to industry to determine whether it will take the quick amortization or depreciate over the normal period.

New York Woodlands

New York forest lands are growing sawtimber 34% faster than it is being removed through harvests, fire, insects, and disease combined.

This extremely favorable balance on the state's forest inventory was reported by H. V. Hart, of Deferiet, chairman of the New York Forest Industries Committee, an organization actively pushing forest management of timber resources. His statement was based on new timber appraisal figures just compiled by the U. S. Forest Service.

Sawtimber defined includes all softwood trees 9 in. and over in diameter, breast high, and all hardwood trees 5 in. and over in diameter, breast high.

The state's annual sawtimber growth on its commercial forest area of 12,002,500 acres is 1,041,000,000 board feet, the report shows, while removal through harvest, fire, insects and disease is 777,000,000 board feet.

Since 1945 the total volume of all trees 5 in. and over in diameter has increased from 9,668,000,000 cu. ft. to 11 billion cubic feet, an increase of 14%.

A government appraisal in 1938 showed a sawtimber volume on New York's commercial forest lands of 18,015,000,000 board feet. A reappraisal in 1945 showed 25,279,000,000 board feet. The present volume of 25,481,000,000 board feet represents an increase of 41% over 1938 and 0.5% over 1945.

Federal, state, county, and municipal governments own 22% of New York's forest area. Of this, 2,219,500 acres, or 15.4%, are in the state forest preserves where cutting, even for silvicultural purposes, is prohibited by law. In these state preserves, according to a survey made by state and federal governments in 1952, are 10 billion board feet of sawtimber. This volume is in addition to the 25,481,000,000 board feet in the commercially classed timberlands over the state.

New York State, 47% forested, had a total forested area in 1945 of 13,500,000 acres. The present area, as shown by the report, is 14,500,300 acres, an increase of 7%.

Wisconsin

Twenty million gallons of spent sulphite liquor that two years ago would have been discarded into Wisconsin streams is being evaporated into syrup form and shipped to distant points for use as roadbinder during the next few months, Lake States Roadbinder Association announced recently.

Roadbinder concentrate was first marketed experimentally in Southern Wisconsin, Northern Illinois, and Eastern Iowa last year by Wisconsin Road Chemicals, Inc., of Neenah. Sales in 1954 totaled 500,000 gallons of concentrate, representing 3,300,000 gallons of mill-strength liquor.

This year Consolidated Water Power & Paper Co. at Appleton and Marathon Corp. at Green Bay are shipping concentrated roadbinder to distributors in Wisconsin's Southern tier of counties and adjacent states. Sales already are running ahead of quotas, and present expectations for 1955 add up to better than 3,000,000 gallons of concentrate. That is 20,000 gallons of spent sulphite liquor before evaporation.

Southern Pulpwood Cut

In 1954, the South again harvested a record cut of pulpwood and maintained its position as the Nation's leading pulpwood-producing region. A report recently released by the Forest Service, U. S. Department of Agriculture, shows that the 12 southern states last year cut a total of 16,269,600 cords of pulpwood, 1% more than in 1953. This was 60% of the total receipts of domestic pulpwood at all pulp mills in the United States.

Georgia was the South's leading producer, with 3.1 million cords. Mississippi ranked second with 2.0 million cords. Alabama and Florida were next, with 1.8 and 1.7 million cords respectively. All other southern states except Arkansas, Tennessee, and Oklahoma produced more than a million cords apiece.

Gravure Research

The printing and publishing world has only begun to tap the potential of the rotogravure printing process, according to T. J. Stulz, secretary-treasurer of Parade Publication, Inc., and president of Gravure Research, Inc., in the May issue of Gravure magazine. More than 70,000,000 copies of magazines are now being printed in rotogravure, and Mr. Stulz predicts more to come.

Mr. Stulz also cites increased use of gravure in the printing of labels and packages, partly as a result of the growth of supermarket merchandising methods, and forecasts even greater use of rotogravure in this and other fields.

Mr. Stulz outlines the organization of Gravure Research, Inc., in the question-and-answer article, and summarizes some of the improvements made as a result of research into the transfer of the photographed image to printing cylinders. Some of the potentials of further research in the printing process itself are suggested at the conclusion of the article.

Red Alder for Pulp

Red alder, used at present principally for furniture and fireplace wood, may become a useful source of paper pulp in western Washington. Prolific and fast-growing, red alder enriches the soil by adding nitrogen to it, thus restoring depleted soil for coniferous wood growth. Barking and pulping processes have been worked out by at least one company which expects to use a large percentage of this species in one of its mills in the near future.

Pipe Friction Data

The Hydraulic Institute, 122 E. 42nd St., New York, N. Y., has published a Pipe Friction Manual, available from the Institute at $1.75 domestic, $1.85 foreign.

Pump Standards

The American Standards Association will set up a committee to develop standards for dimensions of low-pressure process pumps, which will allow interchangeability of pumps made by different manufacturers. The project was recommended by the Chemical Industry Advisory Board.

Hunter Museum

The Dard Hunter Paper Museum is now permanently housed at the Institute of Paper Chemistry, Appleton, Wis. The display covers over 18 centuries of papermaking, beginning with paper specimens and ancient papermaking implements from China, birthplace of paper in 105 A.D., and ending with the equipment used by Hunter when he produced handmade paper as late as 1931 in his mill at Lime Rock, Conn.

Protective Coatings

Reinhold Publishing Corp., Dept. 244, 430 Park Ave., New York, N. Y., has published an enlarged new edition of ACS Monograph No. 129, Protective Coating of Metals, by R. M. Burns and W. W. Bradley.

Production Engineering Show

Eight universities will make a joint presentation of their latest research activities at the Production Engineering Show, Navy Pier, Chicago, Ill., Sept. 6–16, 1955. Further details may be obtained from Clapp & Poliak, Inc., 345 Madison Ave., New York 17, N. Y.

Air Conditioning Show

The ninth exposition of the air conditioning and refrigeration industry will be held in the Auditorium, Atlantic City, N. J., Nov. 28 to Dec. 1, 1955.

Automation Show

The Second International Automation Exposition will be held at the Navy Pier, Chicago, Ill., Nov. 14–17, 1955, and will include an electronic computer symposium sponsored by the Chicago Chapter of the Armed Forces Chemical Association.

Coal Miners' Wages

At the outbreak of World War II the earnings of bituminous coal miners had moved well ahead of the average for all other industries, and the differential widened steadily during the war and the postwar period. The following listing is Department of Labor data on average hourly earnings, but making no allowance for fringe benefits, special conditions such as portal-to-portal pay, vacation allowances, etc.

Average Hourly Earnings, February, 1955

Bituminous Coal Mining	$2.50
Average—All Manufacturers	1.85
Blast Furnaces—Steel Works	2.15
Automobiles	2.26
Petroleum and Natural Gas	2.24
Railway Wages	1.98

In addition, of course, the coal industry contract contains fringe and welfare provisions which add substantially to the costs of the employer. A recent calculation of fringe benefit expense in District 8 shows that such items amount to approximately 30% of the direct wage cost itself.

Accident Prevention Aids

The National Safety Council, 425 N. Michigan Ave., Chicago, Ill., has published the 1955 Occupational Safety Services Guide, a complete catalog of accident prevention aids available from the Council.

Structural Engineering Papers

Louisiana State University, Baton Rouge, La., has published Engineering Experiment Station Bulletin No. 49, Proceedings of the Second Louisiana Structural Engineering Conference.

Paper Book Club

Paper-bound books are big business, and are likely to be given a boost by a new organization, Paper Editions Book Club, 2233 Camino Real, Palo Alto, Calif. Members choose from 40 new titles offered each quarter, and receive the usual bonus books.

Industrial Injury Rates

Industrial injury rates for last year, released by the National Safety Council in advance of the 1955 edition of its annual statistical yearbook, "Accident Facts," show a reduction in both frequency and severity of 1954 accidents as compared with 1953.

Twenty-eight of the 40 basic industry classifications reduced their frequency rates, and half of them reduced their severity rates.

The average accident frequency rate for employees in all industries submitting company reports to the Council, based on the number of disabling injuries per 1,000,000 man-hours, was 7.22 in 1954—a reduction of 3% from the year before. The 1954 rate is just about half of the 1946 rate of 14.16.

The communication industry again led all others by turning in the lowest employee frequency rate. Its rate was 1.30. Electrical equipment ranked second with 2.50, followed by the automobile industry with 2.68. The relative position of these industries was the same in 1953. Pulp and paper showed the greatest improvement for the year with a 24% decrease in accidents.

The average accident severity rate for all industries reporting to the Council, based on the number of days lost per 1000 man-hours, was 0.80 last year—a decrease of 4% from 1953.

Communications also had the lowest severity rate, leading all other industries with a rate of 0.13. Printing and publishing jumped from twelfth to second place with a 65% reduction —greatest improvement by any industry. Electrical equipment remained in third place. Wood products had a 62% improvement in its severity rate.

Small Woodlots

The Nation's pulpwood industry will always depend upon the small woodlot owner for a major portion of its raw material, notwithstanding the fact that industry is now spending some $14,400,000 a year in management of its own forest lands.

The importance of the individual landowner in meeting the Nation's demand for pulpwood is pointed up in a new booklet, "Pulpwood Industry Facts," just issued by American Forest Products Industries, national sponsor of the American Tree Farm system and the Keep America Green fire prevention campaign.

1954 Injury Rates by Industry
(Reporters to the National Safety Council)

Industry	*Frequency[a] rate*	*Change from 1953, %*	*Industry*	*Severity[b] rate*	*Change from 1953, %*
Communications	1.30	+ 7	Communications	0.13	+30
Electrical equipment	2.50	−13	Printing and publishing	0.16	−65
Automobile	2.68	−21	Electrical equipment	0.20	− 9
Aircraft manufacturing	2.82	−21	Tobacco	0.21	+24
Cement	3.38	−11	Wholesale and retail trade	0.21	−30
Tobacco	3.42	−22	Miscellaneous manufacturing	0.29	+ 7
Steel	3.85	−19	Aircraft manufacturing	0.30	0
Rubber	3.97	−14	Automobile	0.31	−18
Chemical	4.12	− 9	Rubber	0.39	−20
Shipbuilding	4.23	−21	Leather	0.40	+25
Textile	4.71	−15	Wood products	0.41	−62
Storage and warehousing	5.02	−22	Machinery	0.47	− 4
Miscellaneous manufacturing	5.16	−16	Air transport	0.53	+71
Machinery	6.23	−10	Textile	0.54	+29
Railroad equipment	6.32	− 7	Storage and warehousing	0.56	+100
Printing and publishing	6.68	+ 2	Chemical	0.57	−30
Glass	6.76	− 3	Sheet metal	0.58	−23
Pulp and paper	7.21	−24	Railroad equipment	0.59	−25
All Industries	7.22	− 3	Meat packing	0.59	+26
Sheet metal	7.30	+ 3	Glass	0.62	+35
Iron and steel products	7.91	−10	Service	0.62	+ 2
Petroleum	7.95	−12	Shipbuilding	0.67	−20
Nonferrous metal and products	8.04	+ 1	Gas utilities	0.69	−21
Leather	8.56	−20	Iron and steel products	0.73	− 4
Wholesale and retail trade	8.60	− 3	Petroleum	0.80	−26
Electric utilities	8.62	− 9	*All Industries*	0.80	− 4
Foundry	8.81	−19	Pulp and paper	0.86	− 3
Meat packing	9.79	− 2	Steel	0.87	−19
Gas utilities	10.51	−19	Foundry	0.87	−17
Clay products	11.98	−13	Transit	0.89	+44
Service	12.59	+62	Cement	0.92	−43
Food	13.24	− 1	Food	0.99	+25
Transit	13.67	+ 1	Nonferrous metal and products	1.23	+ 3
Wood products	13.88	−21	Electric utilities	1.52	− 2
Air transport	14.26	+11	Clay products	1.78	+18
Quarry	14.93[c]	..	Construction	2.29	+11
Construction	17.29	+10	Quarry	2.62[c]	..
Mining, other than coal	22.95[c]	..	Mining, other than coal	3.14[c]	..
Marine transportation	24.10	+ 9	Marine transportation	3.16	+116
Mining, coal	25.81[c]	..	Lumber	3.68	− 6
Lumber	30.88	− 8	Mining, coal	4.79[c]	..

[a] Disabling injuries per 1,000,000 man-hours. (A disabling injury is one which results in the complete inability of an injured person to perform his usual activities for a period of at least 24 hours after the time of injury or results in some permanent impairment.)
[b] Time charges (in days) per 1000 man-hours.
[c] 1953 rates.

"Most of the pulpwood comes from small ownerships and farm woodlots owned by more than 4,222,000 persons," the booklet points out. "It is probable that the number of people who grow and sell pulpwood in the Nation runs into the millions."

In the five recognized pulpwood-producing regions, the proportions supplied by farmers and other small landowners is listed as follows: Appalachian, 69%; South, 70%; Northeast, 30 to 50%; Lake States, 50%; Western Region, "a small amount."

Pulp companies, which own or lease only 6% of the Nation's commercial forestlands, will always have to buy millions of cords of pulpwood annually from farmers, even after their own lands reach capacity production some 25 years hence. In view of this, the thousand-or-more technically trained foresters now employed by pulpwood companies are giving increasing attention to providing technical assistance to farmers and small landowners who otherwise might not obtain it.

—from *The St. Croix Observer*, June 1, 1955.

Chemical Debarking

Chemical debarking is a useful tool, not only of practical value in planning and executing logging schedules, but also in silvicultural treatment of the forest.

This announcement by Edwin C. Jahn officially brought to a close a four-year research project conducted by the State University of New York College of Forestry at Syracuse.

The $175,000 research program was sponsored by 17 pulp and paper and chemical firms. It was undertaken to learn more about factors influencing chemical debarking, to determine the movement and distribution of the chemical in the tree, and to ascertain its effect on the living tissues. The practicability of applying a toxic chemical to the living tree during the sap-peeling season was proved in work on the college's Huntington Forest and on company-owned lands in New England, New York, and Pennsylvania.

Glassine & Greaseproof Booklet

The Glassine & Greaseproof Manufacturers Association, 122 E. 42nd St., New York, N. Y., has put together a handy sample book illustrating some of the more popular types of glassine and greaseproof papers that are currently in use.

Atomic Waste Treatment

The National Council for Stream Improvement is about to institute a project at Columbia University to determine if the gamma radiation emitted from spent billets of radioactive material from atomic power plants can be employed for treating sulphite, kraft, and semichemical pulping effluents. The billets, after removal from power reactors, have to be "cooled" of their gamma radiation prior to reprocessing. Hence, it appears that a large source of gamma radiation will be available and uses for it are being sought.

At the annual meeting of the National Council, Professors W. Selke and E. Henley of Columbia University presented a paper on the subject which showed the ability of this radiation to oxidize and decompose organic compounds. As the material radiated does not come in contact with the radiation source it does not become radioactive. Professors Selke and Henley will be in charge of these investigations.

Waste Treatment Survey

The 1954 Annual Report of the National Council for Stream Improvement estimates that the pulp, paper, and paperboard industry has expended in the neighborhood of $70 million for waste treatment plant construction over the past ten years. This estimate is based on a recent survey of 329 mills by the National Council staff indicating that 55% of the mills in the survey sample have installed waste treatment facilities. Five years ago a National Association of Manufacturers survey of water usage and waste treatment in industry showed that 37% of all paper mills in the United States had waste treatment plants. These figures would indicate an accelerated rate of treatment plant construction by the paper industry.

Water Reuse in Kraft Pulping

On the recommendation of the Southern Regional Technical Subcommittee of the National Council for Stream Improvement, a survey of practice with respect to water reuse in kraft mills is under way. This project is of importance because some units of modern, improved recovery systems discharge water more suitable for certain mill uses than the clean process water itself. Higher reuse generally improves over-all recovery, as well as decreasing need for fresh process water. The latter is a necessity at some locations due to decreasing availability and large production expansion. The first step in the survey is the collection of flow sheets from the mills.

The survey will be accomplished by mill visits by Council engineers. When the data obtained are examined and tabulated, specific recommendations regarding water reuse based on experience can be made and the direction to proceed in respect to further reuse will be indicated.

Water Testing Methods

The tenth edition of "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes" has recently been published by the American Public Health Association, Inc., 1790 Broadway, New York 10, N. Y. These are the official methods recognized by courts of law and employed by government regulatory agencies for examination of mill effluents and receiving waters. Copies are available from the Association at a price of $7.50.

Rainmaking

Wide interest in rainmaking for producing more water in watersheds, controlling forest fires, and increasing wood yields has been exhibited by the pulp and paper industry. Speaking recently before the Mobile-Pensacola section of the American Chemical Society, W. E. Howell of Howell Associates and Harlan Shope of International Paper Co. described at length rainmaking activities in this country. Statistical analysis of data obtained over a wide area indicated considerable success for the techniques employed. With the present high drought frequency pertaining in the South, rainmaking may become a practical necessity in the future.

Folding Cartons

An information program to spotlight the essential role of the folding carton in the American economy is planned by the Folding Paper Box Association of America. The program was designed to create closer cooperation between folding box makers and such package-conscious groups as manufacturers, trade associations, package designers, purchasing agents, wholesale and retail distributors, and consumers. While the American public buys more than 100 billion paper cartons a year as carriers and protectors of its food, beverages, tobacco, textiles, cosmetics, hardware and other goods, too few people have recognized the creation and production of these cartons as the dynamic, fast-growing industry it is.

Today, there are 572 companies making folding cartons with an annual volume of $800,000,000—up from $277,000,000 a decade ago. The Folding Paper Box Association will expand its activities to provide information on the key role of the folding carton in modern merchandising and marketing. To assist in the program the Association has retained the public relations firm of Carl Byoir & Associates to work with the group's staff and member companies.

Today successful merchandising is based on a combination of mass volume and display, self-service and package selling.

The whole system of mass promotion and mass merchandising is pointed toward the brief instant when the customer comes in contact with the merchandise in its package in the retail store. In that instant, the package alone can make or break the whole merchandising and advertising program.

The full program will seek five broad objectives:

1. To show manufacturers, wholesalers, processors, and retailers how better packaging generally and folding cartons specifically can mean greater efficiency, faster turnover, better displays, and more sales.
2. To explain the role of the $800,000,000 folding paper box industry as an important factor in the American business economy.
3. To point out to consumers how folding cartons have made possible more convenient shopping, lower prices, better service, and better-protected, more attractive merchandise.
4. To stress the role of the folding paper box industry in maintaining the high standard of American living, in creating more and better jobs, and in contributing to greater convenience and leisure.
5. To work with schools and colleges in developing courses and information about the key role of packaging in marketing and retailing.

Trees—a Crop

Trees are like plants in any garden. Although the span of time from seedling to mature plant may be greater, trees must be harvested when they are mature. Nature, through one or more of her many agents, will find ways to harvest mature trees if we do not.

The publicity on the spruce budworm helps underline the fact that our forests are a kind of crop. A forest's good health, once it has reached maturity, cannot be prolonged indefinitely. Consequently, the mature forest crop must be harvested to make way for a younger growth. Delaying the harvest of mature balsam fir is an invitation to spruce budworm attack and complete loss of any commercial returns on the portions of the forest destroyed.

"Insect Enemy No. 1" in the spruce fir region is the budworm. Healthy balsam stands can be turned into mere skeletons of their former selves by this insect. What the budworm starts, the bark beetles and wood borers finish—the tree is killed. Sap rot takes over then and within a short time, the balsam is not worth cutting. The top breaks off and the stand soon becomes a tangle of broken and rotted balsam stubs.

Probably no other insect has caused such widespread damage in this country as the spruce budworm. In recent years, extensive outbreaks have occurred from eastern Canada to the forests of the United States west coast.

Strange as it may seem, most of the havoc wrought by this not too ugly looking pest is unnoticed by the ordinary layman. However, evidence of the insect's enormous capabilities can be pointed out by the experienced forester and woodsman.

When the population of the budworm is heavy, all the needles are eaten off the trees, giving an over-all grey appearance. When the population is lighter, many needles are chewed off at the base and are not eaten—these turn reddish brown. There is little hope for recovery once the needles and buds have been eaten.

The seriousness of the budworm attack can be better understood when we note the size of a counter attack launched against the insect recently in New Brunswick, Canada. An insecticide spraying program was conducted over large acreages of that southeastern province. Fifty planes operating from five bases covered approximately 4,000,000 acres of forest under heavy budworm infestation during the past three years. This tremendous project reportedly cost approximately $1.50 per acre and the results have been somewhat disappointing and are only temporary at best.

What is the answer to this problem?

Once again the applied study of the scientist has come up with a relatively simple solution to a serious problem. Basic research on the project was done by the Canadian Division of Forest Biology. Kimberly-Clark's Forest Protection of our Woodlands Department applied the findings of this Canadian agency to our own experiences and locale.

A brief review of the life history of the budworm will help us understand the line of attack the corporation is now promoting.

In early August, the female moth lays her eggs on the needles of spruce and balsam trees. From eight to twelve days are needed for the eggs to hatch. The newly hatched budworms do not feed, but move about finding a suitable place to spin their silken case, then hibernate for the winter. Up to now, no damage has been done.

In spring, the budworms emerge in time to find the balsam fir in fresh foliage. The black spruce opens too late to supply food for the budworm at this critical period.

Mature balsam fir foliage appears at the proper time and remains green and tender during the entire period of budworm development. The budworm does its greatest damage as it nears full growth in July.

The key to the survival of the young budworm is the tiny balsam flower it feeds upon during its first week out of hibernation. The number of young budworms that can survive is in direct relationship to the amount of balsam flowers in the stand. Mature balsam trees flower abundantly, much as mature apple trees. The many-flowered balsam is the factor we can do something about if we would control the budworm population.

Cutting is the main tool in this phase of forest management. The areas that have mature and over-mature balsam entering the abundant flowering stage should be cut. Balsam stands must be operated on a short rotation. They should be kept in a healthy and fast growing condition. Any area in the spruce fir type with a fairly well-regulated distribution of age classes need not fear the spruce budworm.

Delaying the harvest of mature balsam can be compared with delaying the harvest of mature, ripe tomatoes. The latter soon become worthless and, although the time factor is expanded, the same is true for balsam.

Kimberly-Clark is asking other land owners, timber operators, and tree farmers to make an effort to keep their stands in the best growing condition and treat them as a crop. This will mean a greater timber growth on a given area and it will give operators work every year on a continuous basis. It will also help the community, the state, and the Nation and at the same time reduce the loss caused by the budworm.

—from *Cooperation*, June, 1955.

Paper Industry—a Sound Investment

Faith in the continued growth potential of the paper and paper products industry received strong support recently from the management of the third largest common stock mutual fund. Fundamental Investors, Inc., states in its quarterly report that substantial increases have been made in paper and paper products holdings.

Managers of this $270,000,000 fund have selected Crown Zellerbach Corp. as the choice investment in the industry by purchasing 12,000 shares of common stock. Fundamental now owns 279,000 shares in paper and paper products companies with market value of about $18,216,000.

Also included in the portfolio are Champion Paper & Fibre Co., Container Corp. of America, Dixie Cup Co., International Paper Co., Kimberly-Clark Corp., Lily-Tulip Cup Corp., Mead Corp., and Union Bag & Paper Co.

Rayonier

Otto H. Sangder has been appointed assistant pulp mill superintendent of Rayonier's Grays Harbor Div., Hoquiam, Wash. P. M. Toppari succeeds Mr. Sangder as chief chemist and Edward Button is now assistant chief chemist.

Great Lakes

A $20,000,000 expansion program at the Great Lakes Paper Co., Ltd., Fort William, Ont., was announced June 8 by Lands Minister Mapledoram.

The program will involve installation of a new newsprint machine, one of the first in Northwestern Ontario since 1929.

The installation, to start immediately, will raise production of newsprint from 150,000 tons to 260,000 tons. It will require an additional 100,000 cubic cords of pulpwood annually, providing jobs in timber operations for some 900 more men.

Shelton

"Shallow and swift are the waters of Hammersley Inlet, a salty arm of Puget Sound reaching into the heart of Mason County. 'Big Skookum'—meaning big and strong—was the Indian name for this pathway over which small craft, steamboats, tug-towed barges, and log rafts have traveled since pioneer times."

So wrote Dave James of Simpson Logging Co. in his story, "100 Logging Years in Mason County."

Simpson Logging Co. was 60 years young June 16—a simple statement but so important to the community of Shelton, on Hammersley Inlet, in the State of Washington.

Sol G. Simpson, founder of the company, came to Mason County in 1887 to build a railroad for Capt. William Renton, pioneer sawmill operator in the Pacific Northwest. He was one of the first men in the Douglas-fir country to use horses in place of bull teams for yarding logs to the railroad landings. His experience in railroading taught him that horses were faster, smarter, and easier to handle. They brought out more logs.

Sol Simpson kept on being smarter and faster. From the modest beginning he made in 1895, Sol's logging operation created a forest products manufacturing organization which has spread from the Canadian border into the redwood region of California. But Shelton still remains the hub of Simpson Logging Co.

Today Simpson Logging Co. has a payroll in excess of 2000 men in the area called the Shelton Working Circle. In Shelton itself are two sawmills, a plywood plant, and a wood fiber plant making insulating board products and acoustical materials. At nearby McCleary is a door factory and additional plywood manufacturing facilities. As a backdrop Simpson farms a forest mantle of 300,000 acres of the finest timber growing land in the world, operated on a sustained yield basis. Simpson's forestry department manages this acreage for all the forest products the soil will bear, engaging in fire and pest control, natural and artificial reseeding, building and maintenance of roads. Besides the tree harvest, the land yields tree seeds, fern, huckleberry and salal brush for florists and Christmas trees.

When you say Shelton, you also add "and Camp Grisdale." Their combined annual forest industry payroll runs better than $12,000,000.

Camp Grisdale, operated by Simpson Logging Co., lies 50 miles west of Shelton. It has modern homes for families, comfortable quarters for single men, an elementary school, combined gymnasium, community hall and bowling alleys, soda fountain and athletic field. It is a far cry from the old-time logging camp of straw mattress, and pot-belly stove surrounded by racks of steaming-wet wool socks.

Shelton is the retail center for an area larger than Rhode Island. It is the common meeting point of all roads on the southeast corner of the wild Olympic peninsula, hemmed in as it is by Oyster Bay, Pickering Passage, Hood Canal, and the massive barrier of the Olympic range to the west.

A booklet from Shelton's Chamber of Commerce says of this domain. . . . "Year 'round beauty swells in this region; richly mantled with Christmas trees, tall forests and greens which carpet the woods. Ferns, cascara bark, and huckleberry bush are shipped from Shelton to the markets of the world." While it is impossible to accurately tabulate the value of all minor forest products shipped out of the Shelton area, surely it is the minor forest products center of the United States.

Shelton is the original home of Rayonier Inc., manufacturer of chemical cellulose commonly called dissolving pulp. Most of the rayon producers in the United States obtain part or all of their chemical cellulose requirements from the company. The very name of the company stems from its dominant place in the rayon industry. Beginning as Rainier Pulp & Paper Co. in 1926, the name Rayonier was coined when the Rainier mill merged in November, 1937, with two other mills, the Grays Harbor Pulp & Paper Co. of Hoquiam, Wash., and the Olympic Forest Products Co. of Port Angeles, Wash.

Although Rayonier now has mills in Fernandina, Fla., and Jesup, Ga., Shelton is still the research center for the company's broad experimental program which covers a wide range of known and potential uses for wood cellulose. A recent product announced by the Shelton laboratory is "Rayflo," derived from hemlock bark for use as a thinning agent in the making of oil well drilling fluids or "muds." The Shelton Research Division is one of the largest and best equipped in the United States engaged in research related to the manufacture of chemical cellulose derived from wood.

Shelton lies deep in Tree Farm country. Immediately west of town begins the mammoth South Olympic Tree Farm, incorporating 177,000 acres of private tax-assessed forest land within a boundary area encircling 350,000 acres. The first forest lands to be certified within the area were owned by Simpson Logging Co. This was in the summer of 1943. Then Simpson was joined by the Milwaukee Land Co. and Weyerhaeuser Timber Co. in an organization incorporated under the laws of the State of Washington and called the South Olympic Tree Farm Co. Additional acreages were added from time to time by the parent companies and some holdings to form the present total. A year around crew of industrial foresters operates the Tree Farm under managing forester Oscar Levin.

Either touching the boundaries or close to the South Olympic Tree Farm are other certified industry-managed Tree Farms. To the south is the Weyerhaeuser Co.'s Clemons Tree Farm, birthplace of the American Tree Farm System. Others are the Port Blakely Tree Farm, Schafer Bros. Tree Farm, Rayonier, Inc. Tree Farm, and to the northeast across Hood Canal, the Pope & Talbot Tree Farm. Taking up the northwest sector is Uncle Sam's managed tract, the Olympic National Forest.

West Tacoma

Culminating several years of timberland acquisition for the purpose of going on a sustained yield basis, the West Tacoma Newsprint Co. of Steilacoom, Wash., has joined the ranks of the American Tree Farm System with the certification of two tracts as West Coast Tree Farms.

West Tacoma Newsprint Co. is a joint venture of 44 West Coast newspapers for the purpose of supplying the newsprint needs of the stockholders. The company began with no timberlands, but soon found it necessary, in stabilizing its future plans, to set up a full-fledged forestry and timber department.

Coosa River

Study of plans for increasing the production of newsprint has been authorized by the directors of Coosa River Newsprint Co.

The 5-year-old publisher-owned mill started with an annual output of 100,000 tons of newsprint. Last year the company sold 122,281 tons of newsprint and 58,918 tons of pulp. With additional equipment, the 1955 production will run to 132,000 tons and a stepup to 152,000 tons by 1957 is already planned.

Crown Zellerbach

Crown Zellerbach Corp. has announced plans for the construction of a 22-floor multi-million dollar headquarters office building in downtown San Francisco at the junction of Market, Bush, and Battery streets. The paper manufacturing corporation's new headquarters is expected to be completed in mid-1958.

Crown Zellerbach Corp. has announced that a new paper machine, with a designed annual capacity of 50,000 tons of kraft papers and newsprint, will be built at the Duncan Bay, B. C., mill of the Elk Falls Co., Ltd.

The new machine and supporting facilities, plus the new kraft pulp mill construction program already under way at Duncan Bay, will raise to $25 million current expenditures by the company on Vancouver Island.

Other highlights of the accelerated program are:

The present 400-ton kraft mill under construction will be redesigned to produce 500 tons a day.

A bleach plant with a daily capacity of 175 tons will be built.

A substantial addition will be made to the present groundwood mill.

A sawmill will be built, which represents a departure from purely pulp and paper manufacturing operations at the mill.

Production on the new paper machine is scheduled to begin in mid-July, 1957, at which time the redesigned kraft mill will also be in full operation.

The new paper machine will be installed alongside no. 1 machine which has been producing newsprint since 1953. It will make bleached, semibleached, and unbleached kraft papers and newsprint largely for domestic consumption, Mr. Youngman announced.

Glatfelter

Celebrating its 50th year in business, the Perkins & Squier Co., 225 W. 34th St., New York, N. Y., has placed its 40,000th order with P. H. Glatfelter Co., Spring Grove, Pa. for book publishing paper.

The Book of the Month Club, Inc. will use the paper from this order for a large printing of John Gunther's *Inside Africa* for distribution to its members as its October selection. Perkins & Squier Co. and P. H. Glatfelter Co. have been exclusive supplier to Book of the Month Club for their uncoated book and offset paper requirements for books for approximately 22 years.

Perkins & Squier Co. has been the sole distributor for Glatfelter book publishing paper since 1920. During this 35-year period, the list of customers has grown from a few to a group that now represents a large proportion of the nation's most important book publishers.

Officials of the P. H. Glatfelter Co. witness the shipment of the 40,000th order received from Perkins & Squier Co.

During its 50 years in business Perkins & Squier Co. has always specialized in paper for book publishers, and has now become one of the largest distributors in this field.

Bearing in mind the constant increased demand from the book publishers, as well as commercial printing, Glatfelter has started a $12,500,000 expansion program incorporating a new paper machine. This will increase Glatfelter's tonnage by approximately 50% over present production.

Rome Kraft

To Swedish-speaking people, the word "kraft" means "strong." To Americans, it has come to mean the high strength brown paper made by Rome Kraft Co. and other Southern paper mills today by means of the "sulphate" process. This process—it takes its name from sodium sulphate, one of the principal raw materials used—is designed to separate the cellulose fibers in the pine wood from the other materials present. It was first proposed in Europe in 1879 and was slow coming into wide use in this country. Recently, its growth here has been speeded up greatly, when it was found how many new uses the strong fiber is valuable for, especially in the manufacture of corrugated shipping containers and packages.

Since the first use of the sulphate process, continuous advances have been made in equipment and procedure. These advances have been very rapid in the past 10 to 15 years and have reached full development at Rome Kraft Co., Rome, Ga. Here, almost all chemicals are recovered and processed to use again. Even the dust, which used to be lost while processing chemicals, is recovered by the latest methods. Heat recovery has been highly developed so that less oil and coal are required for fuel. All of these developments, together with the recovery of by-products, mean more and better Rome Kraft containerboard at less cost.

The basis of all paper is cellulose, the most important and abundant organic material on earth. The forest is its greatest source of supply. Even though paper can be made from almost any fibrous raw material, no source of cellulose has been found that can equal wood in cost and number of final products.

Young pines like those that grow so abundantly in Georgia are about 50% cellulose, aside from the moisture they contain. This is the material that Rome Kraft converts into one of man's most useful products—paper. Four major native varieties of pine are used to make the containerboard—longleaf, shortleaf, slash, and loblolly.

How Wood Is Prepared

Pine is brought from the forest to the wood yard by a continuous stream of trucks and railroad cars. Every 24 hours, 1300 cords are converted into high quality containerboard in the mill. Of this amount, nearly 30% is trucked into the plant from within a 50 mile radius of Rome. The rest comes from further out in Georgia, Tennessee, and Alabama. Private producers and small land owners supply most of this enormous amount of pulpwood to Rome Kraft Co.

After unloading, the wood is conveyed to three barking drums, which perform the first step of the complex operation of making paper. The drums are 12 ft. in diameter and 45 ft. long; they rotate six times a minute. As the logs drop into the drums, they are continuously tumbled, rubbed against the sides and against each other until the bark falls free. It drops through slots in the sides of the drums onto a conveyor. Although the bark has no value in papermaking, it is put to use as a fuel, heating one of the high pressure boilers in the power plant.

The cleaned logs speed into the mouths of two chippers where they are cut into chips about $^5/_8$ in. long. The chippers are heavy spinning disks, 90 in. across, with ten knives mounted on their faces. They are driven by 600-hp. electric motors. Each of the chippers chews up 40 logs a minute—

one every second and a half. The river of chips that pours out of them is carried by conveyor belts to storage bins and then to the digesters to be made into pulp.

Making Pulp in the Digesters

The eight digesters are large steel cylinders 12½ ft. across which stand six stories high. They perform the important step of separating the cellulose fibers from the other materials in the chips.

About 55 tons of pine chips are loaded into each digester. Thousands of gallons of cooking caustic—a solution of ¾ sodium hydroxide and ¼ sodium sulphide—is added. About 85% of the chemicals used in cooking are later recovered and used again. The loss is made up by adding sodium sulphate in the recovery furnace; the process takes its name from this fact.

The digester is capped and sealed, and live steam is put into it until the inside pressure reaches 110 p.s.i. For two and a half hours, the chips cook in the strong caustic solution.

As the wood cooks, turpentine is condensed from the vapors drawn from the digesters. About 900 gallons of turpentine are recovered every day and sold as an unrefined by-product to paint manufacturers.

In the meantime, the cooking caustic penetrates to the center of each chip and dissolves the gummy and resinous matter. This frees the individual fibers of cellulose, which are left suspended in the solution, which is now called pulp.

Preparing the Pulp

Pulp moves from the digesters to a four-stage washer. This operation washes away the spent chemicals, together with the unwanted material they have dissolved out of the wood. This leaves the cellulose fibers clean and free.

The concentration of chemicals decreases at each stage of washing, and after the fourth stage, the clean pulp flows to the screens. Each screen is actually a rotating plate perforated with many small holes through which the fine fibers of the pulp pass. Partially cooked and oversized particles are held back and returned to the digesters for further cooking. The good pulp passes on to the deckers where it gets a final washing and is thickened by draining away most of the water.

From the deckers, the pulp flows to the refiners. Fourteen disk refiners smooth out and further separate the little bundles of fibers by mechanical action. The individual fibers are made pliable and their ends frayed out so that they will interlace later on the wire of the paper machine and form a stronger sheet. During the refining operation, small amounts of chemicals are added to give the finished sheet the required resistance to water.

Through all the pulp preparation stages, the flow of the pulp stock is controlled primarily by Crane valves that are specially designed for this purpose. They prevent clogging and provide tight closure with their shearing-action disk.

Turning Pulp Into Containerboard

More than 650 tons of containerboard are made every day on the Rome Kraft paper machine. This 490-ft. long, 252-in. wide, and two-story-high monster is one of the largest paper machines operating anywhere in the world.

Refined pulp is pumped to the headbox of the machine and diluted with large quantities of water, until the dilute suspension contains only about ½ of one per cent of pulp. This flows from the headbox onto the fourdrinier wire, which is an endless wire belt 252 in. (21 ft.) wide and 140 ft. in circumference. A portion of the "wet end" of the machine shakes sideways to spread the fibers evenly over the surface of the wire, arranging them so a uniform sheet of paper will form.

As the wire travels with the sheet of paper forming on its surface, the water drains through, first of its own accord, and next by a suction being applied below the wire. The water drained through is used again and any fibers it contains are saved.

After it leaves the wire, the wet web of paper is carefully carried on woolen felts into the press section. More water is removed by squeezing the paper between three pairs of rubber-covered rolls. From the presses, the paper passes into a series of 89 driers. These drums are 5 ft. in diameter. They are heated with steam to 300°F. or more to drive still more water out of the paper. Every hour, the machine evaporates 44 tons of water or 1½ tons of water for every ton of paper.

From the driers, the paper enters the calender section where it is given its final finish. As it passes between a series of steam-heated metal rolls, the surface is smoothed by means of friction and heavy pressure. After leaving the calender section it is wound on a large reel. These 12-ton rolls of paper are next carried to the winder where the paper is cut and rewound into rolls of the size ordered by customers. The winder travels at 4200 ft. a minute, and can rewind a 12-ton roll in 15 minutes.

The continuous sheet of paper coming from the paper machine is 19½ ft. wide and is traveling around 1500 ft. a minute. To insure constant quality, chemical solutions are analyzed throughout the process and regular physical checks performed on the paper so any correction needed can be made as quickly as possible.

How Containerboard Is Used

Rome Kraft ships 8000 carloads of containerboard every year to box manufacturers in almost every part of the United States. In their box plants they convert containerboard and corrugating board into corrugated boxes which are shipped throughout this continent and overseas. Numerous manufacturers and industries depend almost exclusively on corrugated boxes for safe, economical shipment of their products. Textiles, soap, blood, glass, tobacco, floral and food products (ranging from canned goods to frozen foods) are but a few of the items that eventually travel in the familiar kraft box. And the box manufacturers are continually applying their considerable ingenuity to devise new corrugated packages for an expanding number of products and uses.

Corrugated boxes are used for shipping practically "everything under the sun," to provide all of us with our comforts and necessities.

WAUSAU

Instrumentation is essential in the changeover from calcium to ammonia base pulping—CaO to NH_3 to permit the use of various wood species. One of the first paper mills in the United States to change from CaO to NH_3 base was the Wausau Paper Mills Co. of Brokaw, Wis., in 1953. It produces about 100 tons per day of bleached sulphite ledger, bond, and other papers. The changeover to ammonia not only permitted the use of various woods but facilitated a production increase.

Engineering and instrumentation removed old-fashioned guesswork from the new acid plant and other facilities designed for the ammonia base process. The absorption tower is a 48-ft. steel cylinder tile-lined, 6 ft. in diameter, which encases layers of glazed spiral rings. Fifty-four thousand small mixing units, stacked end on end, form a filter bed where controlled portions of sulphur gas and aqua ammonia merge with water shower sprays, forming high grade cooking acids. Circulating lines, port inlets, circular ramps, and ladders are conveniently located at strategic points for easy maintenance inspection and control. Fischer & Porter Flowrator meters with pneumatic transmitters measure flow rates of water to the spray cooler; sulphur gas to the tower; ammonia; and recirculation water. The flow rates are transmitted to F&P pneumatic controllers which monitor valves in the flow lines for close control of the system. Liquid level control, temperature control, a recorder at the combustion chamber, and auxiliary level gages at all storage points complete the instrumentation system for the entire process.

The completely renovated features of the plant, plus time-saving push button control, have generally increased over-all efficiency in addition to permitting the flexibility of processing various wood species.

—from *Ratonews*, May, 1955.

International Paper

During the 1954–55 planting season, International Paper Co. planted on its own lands in the south, or distributed to other landowners, a total of 28,200,000 pine seedlings. Of the total figure, 16,500,000 seedlings were planted on company-owned land while 11,700,000 seedlings were given to other landowners.

Plantings on company-owned land were carried out in nine southern states, but the largest number of seedlings, 4,000,000, were planted in Florida. Most of these were located in the vicinity of the company's Panama City mill. Here, as in the other locations, seed trees were not of sufficiently high quality to restock the area naturally. Since this program started, International Paper Co. has planted more than 100,000 acres of woodlands in the south.

Gair

Shelley Schuster has been named general district manager of the newly formed Southern Container District of Robert Gair Co., New York, N. Y. General sales manager of the new division is C. C. Viguerie and Paul E. Oliver is general superintendent.

Riegel Carolina

Personnel of the Woodlands Division of Riegel Carolina Corp., Acme, N. J., is as follows: Walter Brewer, manager, Robert Richardson, assistant manager, and Ernest Thornton, M. F. Fox, Joseph Matthews, John Haislett, Howard Mills, and Everett Howell, area managers.

Consolidated

George Royan has been appointed plant engineer of the Appleton Division, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

PCF

Lynwood S. Hatch has retired as vice-president and manager of mills of Penobscot Chemical Fibre Co., Boston, Mass. Edward W. Keith has been appointed manager of mills and Frank B. Harlow is now assistant manager of mills. Gust C. E. Johanson has been appointed superintendent of the Sulphite Division, and Franck P. Morrison has been named superintendent of the Soda Division.

West Virginia

E. F. Libby has retired as construction general superintendent of the Charleston, S. C., mill of West Virginia Pulp and Paper Co., and is succeeded by T. A. Willingham, Jr. R. W. Stoertz has been appointed pulp mill superintendent, and Julius H. Mappus is now technical service superintendent.

Weyerhaeuser

Weyerhaeuser Timber Co. will begin construction late this year of a 400-ton sulphite mill at Cosmopolis in the Grays Harbor area. Expected to cost over $20 million, the new mill will be constructed under the direction of G. F. Alcorn, construction engineer for the company's pulp division.

The sulphite process was chosen for the mill because of the high percentage of western hemlock on the company's forestlands in southwest Washington. A magnesia-base liquor system will be used and the pulp will be bleached for sale to paper and paperboard manufacturers.

Weyerhaeuser is exchanging approximately 45,000 acres of forestlands in Mason county for the same acreage in Grays Harbor county owned by Simpson Logging Co.

KVP

A bug, properly flattened, printed in four colors and waxed, might appeal to an insect fancier, but it's an unwelcome sight in the paper industry—particularly that segment specializing in food protection.

During summer months, mosquitoes and other night-flying insects can prove especially annoying to a paper mill. When these insects tangle with a huge paper machine they become part of the paper in a jiffy.

The KVP Company of Kalamazoo, Mich., manufacturer of food protection papers, keeps paper damage by insects at a minimum through an intensive pest control program; it inspects and sprays nearby fields and plant interiors frequently.

The best way to prevent bugs from becoming a part of food papers is to keep them out of the plant itself. To accomplish this, KVP hires professional "killers," university trained insect specialists of the Industrial Pest Control Service of Kalamazoo. This firm has been protecting KVP's paper from insects for more than 12 years, and doing it year around, inside and outside. Areas around the plant are sprayed to kill the insects in their hiding places. These potential invaders can be any of some 100 different varieties, but the most common are mosquitoes, gnats, chiggers, and June beetles.

Scott

Another important phase of Scott Paper Co.'s West Coast expansion program at Everett, Wash. was completed on June 28 when number four paper machine went into operation several weeks in advance of the anticipated startup date.

The huge machine is located adjacent to its companion, number three machine, which was completed in February of this year. A quantity of supporting equipment which will convert large parent rolls of paper into consumer-sized units, together with pulp preparation equipment has been installed to supplement the production of the new paper machine. Number four is located in the recently completed section of the paper mill at the extreme north end of the Scott property.

Scott Paper Co.'s expansion program at Everett began in May of 1953 when the cornerstone of the paper mill was laid. The first paper machine was completed in December of that year. Number two machine went into operation in July of 1954, followed by number three in February, 1955. The addition of number four machine makes possible increased production of Scott products which are now being shipped to many western markets.

The papermaking facilities are supported by the world's largest bleached sulphite pulp mill which last year underwent an expansion program to provide additional tonnage for the Everett paper mill, for Scott mills in other parts of the country, and the company's pulp customers.

More than 800 people have been added to the Scott payroll during the past 2 years. The current complement of the Everett operation now totals approximately 1400 people associated with pulp and paper production operations, engineering, maintenance, office, and administrative duties. The completion of each phase of expansion has also brought a series of promotions for many employees assuming additional responsibilities related to the production of pulp and finished paper products.

A new high-speed paper machine under construction at the Detroit mill of the Scott Co. as part of a $6,000,000 expansion program under way at that plant should go into operation in October.

The expansion program at Scott's newly acquired pulp and paper plant is part of a long range plan to develop that plant into one of Scott's key manufacturing sites. Present and future plans could add up to a spending program by the company in Detroit of $20,000,000. The program over a 5-year period

could be expected to double production and employment at the Detroit plant which now employs 500 persons.

Scott acquired the Detroit pulp and paper mill only last September and already is producing Soft-Weve Tissue there. A second product, ScotTissue, went into production in June, and tentative plans are being made to introduce other Scott products at some time later this year. Among the new products under consideration is Scott's linenlike paper napkin not yet in full national distribution.

The expansion program includes construction of a series of connected buildings adjoining the present paper mill, the largest of which will house the new paper machine. The other buildings will provide additional pulp storage, paper finishing and shipping areas, laboratories and office space, in addition to employee facilities. Construction of the buildings is scheduled for completion in August.

C-Z-Gaylord

Crown Zellerbach Corp. and Gaylord Container Corp. recently announced plans for the possible merger of these two well-known companies in the paper industry.

The announcement was made jointly by J. D. Zellerbach, president of Crown Zellerbach Corp. in San Francisco and Edwin J. Spiegel, president of Gaylord Container Corp. in New York, on behalf of their respective boards of directors. Mr. Zellerbach and Mr. Spiegel said agreement had been reached in principle on an arrangement under which Crown Zellerbach may make an offer to the Gaylord stockholders to exchange 2 shares of presently authorized but unissued Crown Zellerbach common stock for each 3 shares of outstanding stock of the Gaylord Container Corp. Upon completion of the transaction it is the intention of Crown Zellerbach to increase its dividend rate in order that the present dividend income to Gaylord stockholders may be maintained. Preliminary arrangements to bring the parties together were undertaken by Blyth & Co., Inc., nationally known investment bankers.

Nepco

Final plans have been approved for construction of a large addition to the Port Edwards, Wis., mill of Nekoosa-Edwards Paper Co. to provide increased warehousing and finishing facilities.

When combined with present structures, the new building will present an uninterrupted span of approximately 700 ft. along the north elevation of the mill. A unique architectural feature is the use of arched, cathedral-type windows.

Increased protection for 9-in. diameter counter rolls of freezer paper is provided by sturdy, corrugated cartons in a new packaging method exclusive with Nepco. The new cartons, featuring the easy-open pull tab, are now in use for shipping the firm's two watermarked grades—*Nekoosa* and *King Cold Freezer Papers*—up to 24-in. widths. Standard wrapping will be continued on larger width rolls. The carton carries printed identification on all four sides, as well as color designation stenciled above the label.

Nepco recently installed a Foxboro beta-ray sheet weight profiler, using radioactive thallium 204 as its beta ray source.

Byron Weston

The present officers of the Byron Weston Co., Dalton, Mass., are as follows: Robert Crane, president, Alexander Euston, vice-president and treasurer, Thomas J. Fahey, acting secretary and controller, Frederic S. Klein, mill manager, Franklin J. Nelson, purchasing agent, Thomas H. McKay, power superintendent, Irving M. Witham, engineering and repair superintendent.

Rhinelander

A major plant improvement program now being completed by Lake States Yeast Corp. is designed to upgrade quality of finished products and create a long-term outlet for utilizing more spent sulphite liquor by the pulp and paper industry. Listed among current installations at the local plant are a new bacteriological laboratory, a department for homogenized grinding, and a new division for modified products.

Torula yeast is a relatively new high vitamin protein material in U. S. markets for human and animal nutrition. The Lake States Yeast plant, adjacent to the sulphite pulp mill of Rhinelander Paper Co., Rhinelander, Wis., was the first to make torula in this country and has pioneered many process improvements. The process is of particular interest as a conservation measure because it converts to useful products spent sulphite liquor which previously was discarded into streams.

Increased quantities of spent sulphite liquor will be utilized for manufacture of torula yeast when construction of a new storage unit is completed here early this summer at the sulphite pulp mill of Rhinelander Paper Co. The 125,000-gallon tank now being built will double the mill's present liquor storage, assuring a capacity flow of raw material to the adjoining plant of Lake States Yeast Corp. and a corresponding cut in liquor lost to the Wisconsin River.

Union Bag

With a group of officers who had the courage of their convictions coupled with a broad vision, and the excellent work performed by our employees, the Savannah plant of Union Bag & Paper Corp. has enjoyed a growth that is almost unprecedented in American industry. In 1936 when the plant began operations, we employed between 500 and 600 people. The annual payroll was approximately one million dollars. We manufactured about 150 tons of finished product a day. Today we have 5300 employees, the payroll is just at twenty million dollars a year, and we are producing 1800 tons of finished product every day.

Together with the people employed by the wood contractors and wood dealers, who furnish us with the more than 3000 cords of wood required daily in our operation, we estimate that approximately 9000 residents of Georgia are deriving their incomes directly from the Union Bag & Paper Corp. If we assume that the average family consists of four, this would mean that 36,000 are dependent for a livelihood on our operation.

The cost of our pulpwood is in excess of seventeen million dollars annually and we distribute to the common carriers, such as the railroads and the truck lines more than fifteen million dollars in freight every year.

Despite our rather large land ownership, we depend—and will continue to depend—on the private landowner for the big majority of our pulpwood. Because the small private landowner is the principal source of our wood supply, we feel an obligation to render him every possible assistance. This broadens our community relations program to take in virtually all of the state of Georgia. It is important for us to work closely with the private landowner, to encourage him to protect his trees from fire and to cut them intelligently, and above all to market his trees in a manner that will bring him the greatest return. To aid in this program, we set up in our Woodlands Division a Conservation Department. This department is staffed by 12 carefully selected graduate foresters. These young men are located in various sections of the state and their services, which are free, are at the beck and call of the private landowner who desires counseling, guidance, or assistance.

Having provided you these facts as background, I would like to give you my interpretation of the part a progressive company should play in the community. Actually there is no particular formula for success in building good relations with the community except that which is set up in the Golden Rule. Simply stated, good community relations stem from a matter of "doing unto others as we would have others do unto us," and in the manner in which we conduct ourselves.

It is also true that good relations outside of the plant grow

from good relations inside the plant. In other words, a plant could not expect to enjoy good public relations until it first established good employee relations. This is basic because no amount of effort on the company's part can offset the harm done by disgruntled employees who complain to their wives and neighbors and others in the community about working conditions, wages, and other in-plant matters.

Industrial management today has a definite responsibility to the community and it must earn the respect, the friendship and the confidence of its residents through leadership and active participation in all worth-while community undertakings. A successful program for building good community relations does not just happen—it springs from a sense of responsibility and must have the active support and cooperation of everyone in the organization.

Any community relations program must of necessity be a long range program and it must give due consideration to every segment of the public. We have endeavored to accept our responsibilities to the community, and any contributions we have made in this direction are due in a great measure to the fact that we have been fortunate in bringing together and helping to develop a great number of employees who possess qualities required for accepting community leadership.

Consolidated

Sulphite pollution ended recently at Wisconsin Rapids, Wis., as spent sulphite liquor that formerly discharged into the Wisconsin River was pumped through a mile-long pipe line

Consolidated

Sulphite pollution ended recently at Wisconsin Rapids, Wis., as spent sulphite liquor that formerly discharged into the Wisconsin River was pumped through a mile-long pipe line into two soil filtration ponds, one of them as big as a college football field. Workmen still were putting the finishing touches to this major construction project as the pulp mill by-product began flowing into the man-made reservoirs.

Hereafter, all collectible liquor from the sulphite mill of Consolidated Water Power & Paper Co. will either be utilized for such purposes as roadbinder or else be disposed of by soil filtration.

Hunter's Island was selected for Consolidated's soil filtration ponds after consultation with geologists and the State Committee on Water Pollution as having proper soil and subsoil conditions to make spent sulphite liquor nonpollutional and meet other requirements of the process. The island site made the construction task more difficult. A causeway and bridge had to be built from the west riverbank to transport heavy earth-moving machinery to the job. A 4-in. stainless steel pipe 7100 ft. long—more than $1^1/_4$ miles—was laid and connected with pumping capacity to move 200,000 gallons each 24 hours.

Consolidated's pond is in two sections. Both are 6 ft. deep; one is three times as large as the other. Spent sulphite liquor flows first into the smaller pond, where the heavier components tend to settle out. When the level here rises to a culvert-type overflow pipe, liquor flows through this into the larger pond. As liquor soaks into the earth, soil bacteria eat up much of the sugar and other organic material, thus decreasing its oxygen-consuming character.

Plans for the filtration ponds were completed last year and submitted for approval by the state committee. Construction got started early this Spring promptly after necessary official permission was obtained from other public bodies for changing the shoreline and building bridge and causeway.

Great Northern

Two 200-ton digesters which were part of the first step of the $45 million expansion program of Great Northern Paper Co., East Millinocket, Me., posed quite a public relations problem for the company. The digesters, which were 60 ft. high and 16 ft. in diameter at widest section, had to be transported by truck from Quincy, Mass., to East Millinocket. Although they were broken down into sections for shipment, they still represented such tonnage and size that special permits had to be obtained to move them over the highways.

In order to minimize the inconvenience to motorists, the bulky sections were moved at off-peak traffic hours. Each vehicle was equipped with signs asking the indulgence of motorists and explaining that the equipment was for Great Northern's expansion program which, when completed, would bring benefits to the community.

Rayonier

Rayonier Inc. completed preliminary negotiations with the Prudential Insurance Co. of America for a 25-year $3^3/_4\%$ $100,000,000 loan.

It is planned that proceeds from the new loan will be used for retiring all outstanding loans and notes of Rayonier and its subsidiary, Alaska Pine & Cellulose Ltd., the calling of the outstanding Rayonier $2.00 preferred stock, and for construction of the recently announced 100,000-ton chemical cellulose plant, Rayonier's eighth.

The company anticipates capital expenditures of approximately $80,000,000 during the next 3 years. This includes the cost of the new mill, broad processing improvements in the seven existing plants, and other new facilities. This compares with $95,000,000 in capital expenditures over the past ten years. The sharply accelerated world-wide growth and acceptance of the cellulosics has led Rayonier again to increase its annual production capacity of chemical cellulose and related products, and that the company will have increased this capacity to 900,000 tons by 1957. Current capacity is at 735,000 tons annually, more than doubled since 1945.

St. Regis-Pollock

St. Regis Paper Co. has acquired all of the common stock of Pollock Paper Corp. of Dallas, Tex., as a result of an offer of exchange made by St. Regis. On the basis of the offer stockholders of Pollock will receive 369,999 common shares of St. Regis for the 42,000 outstanding common shares of Pollock.

Pollock Paper Corp., with sales in 1954 of approximately $33,000,000, is a leading manufacturer of waxed paper used in the baking and other industries. It operates a paper mill with one machine at Columbus, Ohio, for a production of a wide range of waxing and specialty papers. It is also an important manufacturer of set-up folding boxes and cartons, corrugated containers, and paraffin cartons used in the packaging of food. In addition, it does a substantial paper jobbing business.

Pollock's plants for manufacturing wax paper are located at Dallas and Houston, Tex.; Atlanta, Ga.; Birmingham, Ala.; Columbus and Middletown, Ohio. Labels are produced at the Middletown plant. Plants for the manufacture of folding cartons and set-up boxes are located at Dallas, Fort Worth, and Mineral, Tex. In connection with its paper jobbing operations, Pollock maintains warehouses in Dallas, Fort Worth, Houston, Lubbock, Mercedes, San Antonio, and Waco, Tex. A large percentage of Pollock's products are delivered by its fleet of trucks.

Lawrence W. Pollock, president of Pollock Paper, has been elected a director of St. Regis.

The holders of substantially more than the majority of the outstanding capital stock of General Container Corp., Cleveland, Ohio, have signed on agreement granting St. Regis options to acquire their shares in exchange for shares of St. Regis common stock. St. Regis will make an offer to all holders of General's capital stock to exchange their shares for St. Regis common stock on the same terms as the present options. Under the terms of the offer, the holders of General's capital stock would receive $2^3/_8$ shares of St. Regis common for each share of General.

General Container, whose principal offices are in Cleveland, had sales in 1954 in excess of $23,000,000. At the end of 1954, General had 134,656 shares of common stock outstanding with no preferred stock or bonds.

General is engaged in the manufacture of corrugated fiber shipping containers and allied products, folding cartons and set-up boxes, and corrugating medium and container chipboard. Its customers include manufacturers of automotive parts, household appliances, food products, metal products, textiles, paper converters, and the jobbing and retail trades.

The products manufactured by General are produced at plants at the following locations:

Corrugated fiber containers and allied products:

Albany Corrugated Container Corp., Cohoes, N. Y.
Canton Corrugated Box Co., Canton, Ohio
Cleveland Corrugated Box Co., Cleveland, Ohio
Dubuque Container Co., Dubuque, Iowa
Hunt-Crawford Co., Coshocton, Ohio
Niagara Corrugated Container Co., Inc., Buffalo, N. Y.

Folding cartons and set-up boxes:

Great Lakes Box Co., Cleveland, Ohio
Crowell Carton Co., Marshall, Mich. (folding cartons only)
Dubuque Container Co., Dubuque, Iowa

Corrugating medium and container chipboard:

Muskingum Fiber Products Co., Coshocton, Ohio

Approximately 1400 persons are employed in General's nine plants. If the negotiations for General's acquisition are consummated, it is stated that the entire General organization will remain unchanged and management continued as in the past with Dan L. Pickering, chairman of the board, and Robert W. Agler, president.

Columbia

Robert R. Howarth has been appointed executive vice-president of the Columbia Box Board Mills, Chatham, N. Y.

Harmac

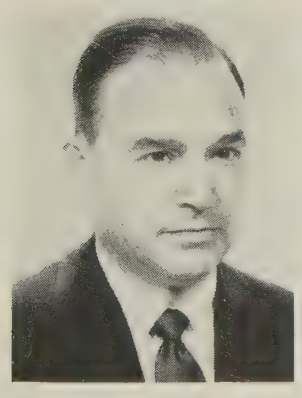
Frank F. Rush has been appointed assistant manager of the Timber & Lands Division of MacMillan & Bloedel Ltd., Vancouver, B. C.

National Container

Vincent H. Urquhart has been appointed production manager of the Long Island City, N. Y., converting plant of National Container Corp., New York, N. Y.

Oxford

H. Paul Petzold has been appointed mill manager of Oxford Paper Co., Rumford, Me., succeeding Walter W. Holland who resigned recently to become vice-president and general manager of the Pulp Division of British Columbia Forest Products, Ltd. Charles L. Ferguson has been appointed assistant mill manager of the Rumford mill, and Harry B. Conner is now general superintendent. Charles H. Claypool has been named mill manager of Oxford Miami Paper Co., West Carrollton, Ohio.



H. P. Petzold, Oxford Paper Co.

C. L. Ferguson, Oxford Paper Co.

Charmin

Completion of all its facilities for manufacturing yeast from spent sulphite liquor is scheduled within the next 4 months by Charmin Paper Mills, Green Bay, Wis.

Since early spring Charmin's big new yeast plant has been in partial production. The new types of equipment are being put through their paces, operating techniques are being evaluated, and personnel is being trained in getting best possible results from the plant facilities. The plant's yeast output has of course been substantially less than design capacity.

Bird

James W. Kemmler has joined Bird & Son, Inc., East Walpole, Mass., as chief chemist of the Research Division, replacing Daniel O. Adams, who has resigned to join the West Virginia Pulp & Paper Co.

Ohio Boxboard

Ohio Boxboard Co., Rittman, Ohio, has spent over $400,000 since 1949 on stream improvement. Installation of a filter system and other plant changes has permitted greater reuse of water and reduced the amount taken from and returned to Chippewa Creek and the Tuscarawas River. The program has affected a 68% reduction in solids content of the mill effluent. Additional improvements now being completed will reduce solids another 23%, and four lagoons now under construction will permit a retention period of eight days before the effluent is returned to the streams.

Olin-Brown

Olin Mathieson Chemical Corp. has agreed to acquire Brown Paper Mill Co., Monroe, La., for $50 million cash and 725,000 shares of Olin Mathieson common stock, valued at about $60 per share. The transaction will more than double Olin Mathieson's timber resources.

Simpson

Richard F. Kenna has been placed in charge of converted product sales for Simpson Paper Co., with headquarters in Los Angeles, Calif.

P.P.R.I.C.

The Pulp and Paper Research Institute of Canada and McGill University, Montreal, Que., have awarded the 1954–55 Gottesman Foundation Scholarship for pulp and paper research to R. R. Schieck of Toronto. With the assistance of this scholarship, Mr. Schieck will carry out thesis work toward a Ph.D. on the flow properties of suspensions of paper pulp, a fundamental study of practical importance to the pumping and mixing power requirements of pulp and paper mills.

University of Maine

Robert Bruce Arnold of Houlton, Me., has been elected the first recipient of a scholarship recently established at the University of Maine by Scott Paper Co. Foundation of Chester, Pa.

The scholarship winner is chosen each year from the junior class. Candidates must be studying forestry or engineering, and have signified an intention to continue for a fifth year of study to complete the management course in pulp and paper.

The award carries a stipend of $1000 during each of the last 2 years of the 5-year course. In addition, Scott Paper Co. Foundation will contribute $1000 to the university during each year the scholarship program is in operation.

North Carolina State College

The Pulp and Paper Foundation, Inc. has awarded 14 scholarships, valued at a total of $23,400 for study in the

The Scholarship Committee of the School of Forestry at North Carolina State College. Seated, left to right: Elmer Leavitt, North Carolina Pulp Co., Plymouth, N. C.; Ian Sim, International Paper Co., Georgetown, S. C.; Ramsey Buchanan, The Mead Corp., Sylva, N. C., chairman of the committee; and Robert Aranow, Riegel Carolina Corp., Acme, N. C., who represented C. E. Hartford. Standing, left to right: R. G. Hitchings, assistant professor of pulp and paper technology; Dean Richard J. Preston and Professor C. E. Libby, director of the pulp and paper program of the School of Forestry, North Carolina State College. H. Y. Charbonnier, Union Bag & Paper Corp., Savannah, Ga., was absent when the picture was made

School of Forestry at North Carolina State College, Raleigh, N. C.

Western Michigan

The following individuals were enrolled for the courses in "Problems and Practice of Coated Paper Manufacture," recently completed at Western Michigan College, Kalamazoo, Mich.:

John W. Welsh, Lee Paper Co., Vicksburg, Mich.; Richard C. Phoenix, Moore and Munger, New York; Jack Johnston, Union Starch & Refining Co., Granite City, Ill.; Norman Nuttall, Hubinger Co., Keokuk, Iowa; Wilbur Noel, Kalamazoo Paper Co., Kalamazoo; Roy F. Traver, Camp Manufacturing Co., Franklin, Va.; Brage Golding, Lilly Varnish Co., Indianapolis, Ind.; J. D. Hitchman, Provincial Paper Co., Port Arthur, Ont.; Leslie Peck, Mac Sim Bar Paper Co., Otsego, Mich.; M. G. Selden, Albemarle Paper Mfg. Co., Richmond, Va.

N. E. Scott, secretary for both the New England Paper Merchants Assoc. and the Boston Paper Trade Assoc. awarded scholarships of $150 each from those organizations to three students enrolled in the paper engineering department at Lowell Technological Institute. Pictured, left to right, are Prof. John Lewis, paper department head; R. C. Savage of Salem, class of '57, New England Assoc. winner; Mr. Scott; F. C. Sharron of Lowell, '58, Boston Assoc. winner; F. J. Wieloch of Dudley, '58, New England Assoc. winner; and Dean of Students, R. W. Ivers

At the Western Michigan coating course, front row, left to right: J. C. Hitchman, Felix Hammack, Leslie Peck, Wilbur Noel, A. H. Nadelman, Frank Marchetti; Second row: M. G. Selden, Miss Carola Trittin, C. V. Silvernail, R. C. Phoenix, Glenn Torres; Third row: Claude McBride, Jack Johnston, Norman Nuttall, Carlton Campshure, R. T. Elias, Joseph Chadderdon; Fourth row: Teodoro Reinhardt, Stanley Hmiel, R. F. Traver, C. R. Vander Meulen, J. W. Welsh, Maurice Larson. Absent, Brage Golding

Maurice Larson, Bergstrom Paper Co., Neenah, Wis.; Carlton Campshure, Appleton Coated Paper Co., Appleton, Wis.; Joseph Chadderdon, The KVP Co., Parchment, Mich.; C. R. Vander Meulen, Penick & Ford, Ltd., Cedar Rapids, Iowa; Frank Marchetti, Titanium Pigment Corp., New York; Stanley Hmiel, Koppers Co., Chemical Division, Pittsburgh, Pa.; Curtis V. Silvernail, International Paper Co., Southern Kraft Div., Mobile, Ala.; Glenn Torres, International Paper Co., Moss Point Mill, Moss Point, Miss.; Claude McBride, The Mead Corp., Chillicothe, Ohio, and Felix Hammack, The Buckeye Cotton Oil Co., Memphis, Tenn.

Instruction was handled by A. H. Nadelman, head of the paper technology department; R. T. Elias, R. N. Zabe, and Miss Carola Trittin.

Much needed space for paper technology studies at Western Michigan College is being carefully studied as a result of the Michigan legislature recently voting $100,000, to be augmented by similar funds from industry for the structure.

It is planned that a three-story addition to McCracken Hall will be constructed, running east and south from the present building, giving classroom and laboratory space on three floors. Ninety students are presently being taught in cramped and borrowed quarters, but with the new addition the paper technology department will be able to carry on in its own facilities. A. H. Nadelman, head of the paper technology department, is now working closely with the architect and college officials to bring this addition into being as soon as possible.

Sandwell

Sandwell & Co. Ltd., Vancouver, B. C., will design and supervise construction of a 35,000-ton annual capacity mill and a complete steam-electric power plant to be built on the Ganges River delta system at an estimated cost of about 65,000,000 rupees (3.4 Pakistan rupees to the dollar or about $20,000,000). Also scheduled is a townsite or colony, to be built over a period of $2\frac{1}{2}$ years at a cost of 3,000,000 rupees—or about $1,000,000. Colony costs, incidentally, will include contributions by the company to local schools and

Mosques. The over-all operation will be known as the Khulna project.

The mill, part of the Pakistan government's current rural expansion and industrialization program aimed at raising the country's living standard, will turn out some 23,000 tons of newsprint and 12,000 tons of mechanical printings (book paper, high quality papers, etc.) annually. Designs are now under way for the project and it is expected that production will commence early in 1958.

The operation, expected to employ some 650 persons, will be powered by steam generators utilizing coal imported from India.

There will be several other industrial plants in the general area, most of which have received financial backing from the government. Based on past performance, the government will later part with its interest through sale of shares to the public. There are a number of jute manufacturers in the Khulna area, while several miles to the East are the Karnaphuli Paper Mills, which utilize bamboo wood in production. These mills are located near Chittagong, East Pakistan's large shipping port.

The Khulna project's production process is of special interest because many of the techniques to be employed are not in general use on this continent. The actual wood used in production, a tropical hardwood known as Gewa, will come from a 1600-square mile region known as the Sunderbans Forest area, located at the delta of the Ganges River system. While British Columbia's much discussed Forest Management Licence Plan has not spread to southeast Asia, forest development is closely supervised by a separate Crown Corporation, which pays special attention to cut, yield, reforestation, etc.

Prior to shipment of some 60 miles to the mill location, the wood will be cut in 4-ft. lengths in the jungle with the work being carried out by local contractors. The logs then will be shipped in barges and stored (piled) unbarked. Owing to the plant's proximity to water, shipping costs will be relatively low. The barking process will be carried out with a conventional mechanical drum barker, and bark will be used in the boilers as an auxiliary fuel.

Tests, supervised by Sandwell & Co. at Madison, Wis., have indicated that at the commencement of production the best pulp mixture will be composed of 65% ordinary groundwood, 25% chemigroundwood, and 10% long fiber chemical pulp.

The accepted conventional method of screening and deckering will be completed before the pulp is passed on to the paper machines. The plant will have two paper machines with a fourdrinier wire width of 146 in., one for newsprint production, one for mechanical printings. The mechanical printings machine will have a size press for adding coatings. The stock in this operation will be mixed in batches and, as might be expected, there will be many small orders with varying specifications.

All production will be marketed locally at the outset but the Pakistan government, mindful of the fact that surrounding countries such as Burma, Thailand, Ceylon, Indo-China, and Malaya, together import about 30,000 tons of newsprint annually, expects to ship to those sources in the future.

Arizona Chemical

The largest tall oil fractionating still in the world went into production recently at Panama City, Fla.

Arizona Chemical Co., the Nation's leading producer of tall oil products, is jointly owned by American Cyanamid Co. and International Paper Co. Arizona Chemical marked the 25th anniversary of its founding recently.

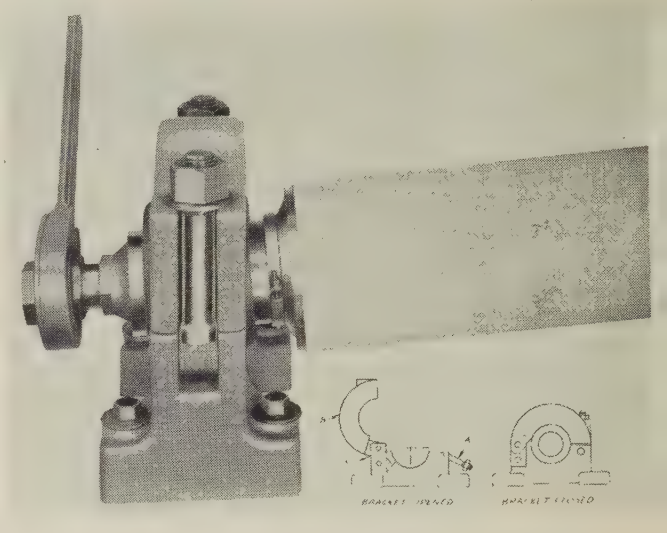
The Panama City plant enlargement increases Arizona's production capacity for fractionated tall oil products to $2^1/_2$ times its former capacity. The expansion was necessitated by increasing demand for the highly fractionated products which Arizona produces for the surface-coating, paint, varnish, soap, and similar industries.

Crude tall oil, a mixture of rosin and fatty acids, is obtained from the by-product liquors of southern sulphate paper mills. The company has a plentiful source of basic material from seven of the kraft mills of International Paper Co. in the south.

The use of tall oil products has grown during the last ten years to the point where tall oil stands third in volume among the inedible fats and oils consumed in industry.

Mt. Hope

The Mt. Hope Machinery Co., Taunton, Mass., is offering two new split type brackets for use with Mt. Hope free



Split-type brackets for Mt. Hope felt expanders

wheeling expanders and felt preserver units for the paper manufacturing and paper converting industries.

Pennsalt

The Pennsylvania Salt Manufacturing Co.'s Engineering Dept. is offering a low cost trial kit of Thick-Coat, its new resin coating product for humid and corrosive atmospheres.

Ebasco

William G. Lauffer has been appointed head of the mechanical plant betterment group of the Consulting Engineering Dept. of Ebasco Services Inc., New York, N. Y., succeeding the late Arthur H. Krauss.

Diamond

The Diamond Power Specialty Corp., Lancaster, Ohio, is offering the multi-port bi-color gage with end stems so that it can be used to replace other gages on existing boilers.

Read Standard

The Read Standard Corp., York, Pa., is supplying eight vacuum pumps for the new Rice Barton paper machine to be installed at the P. H. Glatfelter Co., Spring Grove, Pa.

Dow

William H. Schuette has been appointed general manager of the Dow Chemical Co.'s Midland Div., Midland, Mich.

Ingersoll-Rand

Ingersoll-Rand Co., 11 Broadway, New York, N. Y., has issued a bulletin (form 3188), describing a 125-hp. electric-driven air compressor.

Cleaver-Brooks

The Cleaver-Brooks Co., Milwaukee, Wis., has appointed the Powell Equipment Co., 7623 Greenstone, Houston, Tex. as manufacturers' representative for the sale of C-B boiler and equipment.

Claire Turner, Appleton Woolen Mills

Jack Mazeau, Appleton Woolen Mills

APPLETON

Claire Turner has been appointed sales representative in the Minnesota-Wisconsin-Michigan area for Appleton Woolen Mills, Appleton, Wis., and Jack Mazeau has been appointed sales representative in the New England area.

EARL PAINT

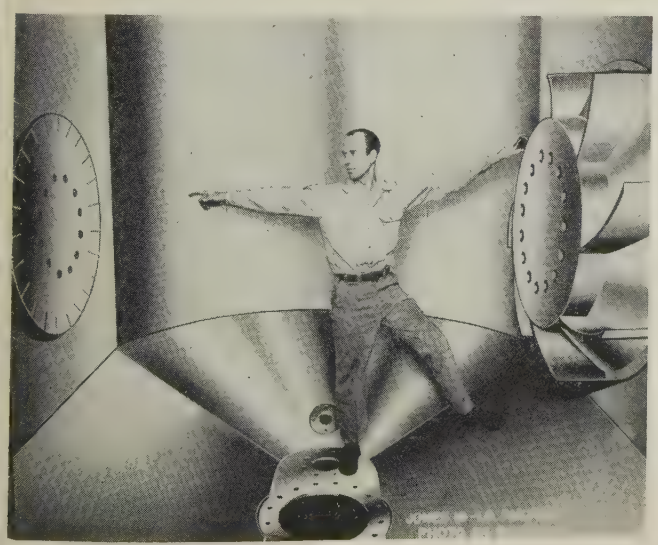
Harold Rogge has been appointed sales engineer for the Northwest territory of the Earl Paint Corp., manufacturers of Erkote Mastics.

ESCO

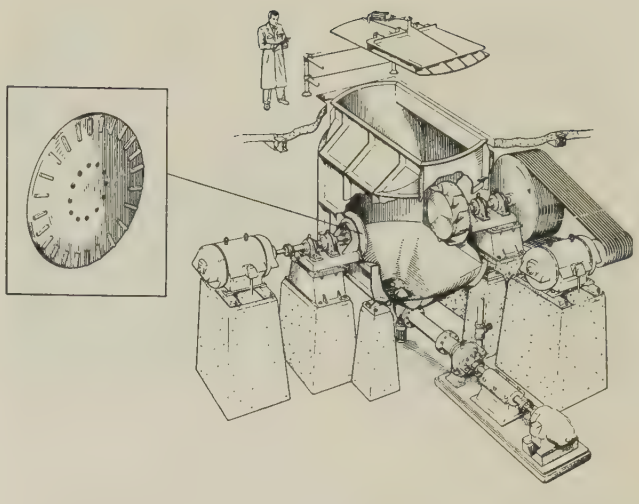
Electric Steel Foundry Co., Portland, Ore., has issued a new catalog (No. 185-B) describing Esco logging rigging.

JONES

E. D. Jones and Sons Co. has introduced a new line of pulping equipment called the Jones Hi-Lo pulper, available in a full range of standard sizes from 500 to 8000-lb. batch capacity. The two primary functions of the pulper, namely agitation or circulation and defibering, are carried out by two different types of rotating element, each of which is designed to perform its separate function at maximum efficiency. With the combination of high and low-speed rotors, we secure a pulping machine that is extremely efficient and also quite flexible. In some cases where a very easy slushing material is to be broken down the pulper may be run with only the low-speed rotor turning. Should it be necessary to defiber Kamyr pressed pulp or heavily sized broke or wet strength materials then the high-speed rotor comes into action and produces very rapid breakdown with complete fiber separation.



Photograph of the Jones Hi-Lo pulper



Schematic drawing of the Jones Hi-Lo pulper

Tests have shown that the Hi-Lo pulper completely defibers difficult materials without affecting the tear in any way.

CONTAINER LABS

Container Laboratories, Inc., Chicago, Ill., has opened a testing laboratory at 435 Stanford Ave., Los Angeles, Calif.

CARTHAGE

Carthage Machine Co., Carthage, N. Y., has published a bulletin (No. 100), describing the new line of Carthage Hydraulic Log Splitters, designed to handle logs up to 24, 30, and 38 in. in diameter and 4 to 8$^1/_2$ ft. in length.

LEEDS & NORTHRUP

Willard N. Greer, a chemical engineer with Leeds & Northrup Co., Philadelphia, Pa., recently observed his 30th anniversary with L. & N.

ANHEUSER-BUSCH

Richard F. Amacher has been appointed sales manager of the Bulk Corn Products Dept. of Anheuser-Busch, Inc., St. Louis, Mo.

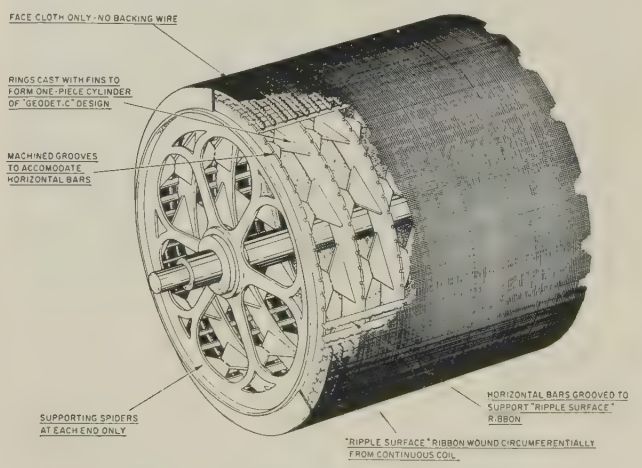
BECCO

John R. Hopkins has been appointed assistant manager of the Southern District sales office of Becco Chemical Division, Food Machinery and Chemical Co., Buffalo, N. Y.

BLACK-CLAWSON

William V. (Bill) Irwin has been appointed chief engineer of Black-Clawson (Canada) Ltd.

B-C is offering a new cylinder mold, called the Black-


FACE CLOTH ONLY - NO BACKING WIRE
RINGS CAST WITH FINS TO FORM ONE-PIECE CYLINDER OF "GEODETIC" DESIGN
MACHINED GROOVES TO ACCOMODATE HORIZONTAL BARS
SUPPORTING SPIDERS AT EACH END ONLY
HORIZONTAL BARS GROOVED TO SUPPORT "RIPPLE SURFACE" RIBBON
"RIPPLE SURFACE" RIBBON WOUND CIRCUMFERENTIALLY FROM CONTINUOUS COIL

Black-Clawson ripple surface mold

J. W. Kolybaba, The Black-Clawson Co.

G. H. de Reus, John W. Bolton & Sons, Inc.

R. M. Leighton, Stowe-Woodward, Inc.

Warren Stubblebine, Stowe-Woodward, Inc.

Clawson ripple surface mold, claimed to provide greatly increased wire life, double the drainage rate of conventional molds, and better formation, due to reduction of turbulence within the interior of the mold.

John W. (Jack) Kolybaba has been appointed sales engineer specializing in fourdrinier machines, for the Bagley-Sewall Division of B-C.

BOLTON

Gerritt Hilbrand de Reus has been appointed Chief Development Engineer of John W. Bolton & Sons, Inc., Lawrence, Mass. Bruno E. Prevost has been appointed vice-president in charge of manufacturing for the company, and Ralph L. Draper has been named chief engineer.

CRANE CO.

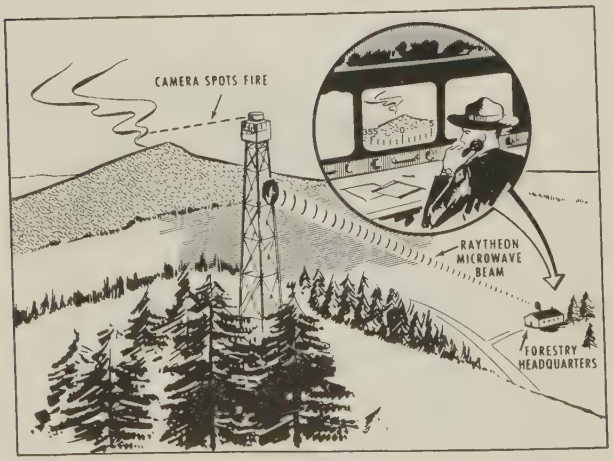
Crane Co., Chicago, Ill., has published a 160-page volume in celebration of its 100th anniversary, entitled "Everything *and* the Kitchen Sink." The new book traces the progress of industry in the United States during the past 100 years, and includes a salute to the paper industry and its part in developing modern America.

HERCULES

Carl W. Eurenius has been appointed assistant general manager of the cellulose products department of Hercules Powder Co., Wilmington, Del.

RAYTHEON

Raytheon Manufacturing Co., Waltham, Mass., is producing "electric fire watchers," television equipment for relaying pictures from lookout towers to forest headquarters.



Raytheon Mfg. Co. electronic fire watch system. Rotating T. V. camera spots fire and beams picture, via microwave, to headquarters. Two or more unattended towers can obtain cross-bearings and pinpoint the blaze

STOWE-WOODWARD

Ralph M. Leighton has been appointed technical service manager of Stowe-Woodward, Inc., Newton, Mass., and Warren Stubblebine has been appointed director of research and development.

TAYLOR

The Taylor Instrument Cos., Rochester, N. Y., recently held a symposium on Frequence Responses for Process Con-

"School" is in session for a group of engineers and physicists meeting at Taylor Instrument Cos. in Rochester to explore the application of frequency response principles to process control

trol, attended by 30 instrument engineers from process industries in the United States and Canada.

BORDEN

Harry W. Cyphers, Jr., has been appointed sales manager of the Durite Department of the Borden Co.'s Chemical Div., Philadelphia, Pa.

Louis L. Nichols, Jack R. Brooks, and Jack C. Waltz have been appointed sales representatives to handle the packaged glues of Borden's Chemical Div.

Borden has completed a new building and installation of new equipment at its Leominster, Mass., plant, which will triple the output of the company's Lemol polyvinyl alcohol.

Borden's Chemical Div. has announced the development of a new dispersion of mildly hydrolyzed casein in water, designated Protovac PL-421.

ALLIS-CHALMERS

R. B. Fulton has been named manager of the Cincinnati district of Allis-Chalmers general machinery division.

A-C has issued a bulletin (20B6082C), describing vari-

pitch sheaves for speed variations up to 76%, by means of pitch diameter adjustment, in capacities from 1 to 600 hp. The bulletin is available from the company at 828 S. 70th St., Milwaukee, Wis. F. J. Geiger has been appointed general manager of Allis-Chalmers Norwood, Ohio works, and Walter B. Lawrence has been named manager of a new A-C sales district with headquarters at Columbus, Ohio.

National Lead

Harold L. Jungmann has been appointed sales manager of the eastern district of National Lead Co.'s Titanium Pigment Corp.

Cyanamid

William H. Bowman has been appointed assistant general manager of the Organic Chemicals Div., American Cyanamid Co., New York, N. Y.

Cyanamid plans to award 17 undergraduate scholarships and 14 graduate fellowships in chemistry and chemical engineering during the academic year 1955–56.

The following new appointments have been made in Cyanamid's Organic Chemicals Div.: W. A. Raimond, assistant technical director; A. G. Hill, resident technical director, Bound Brook, N. J.; R. C. Conn, development manager, dyes and textile resins; R. H. Ebel, development manager, rubber chemicals; W. P. Munro, development manager, vat dyes and vat dye intermediates; W. E. Sisco, development manager, coal tar chemicals.

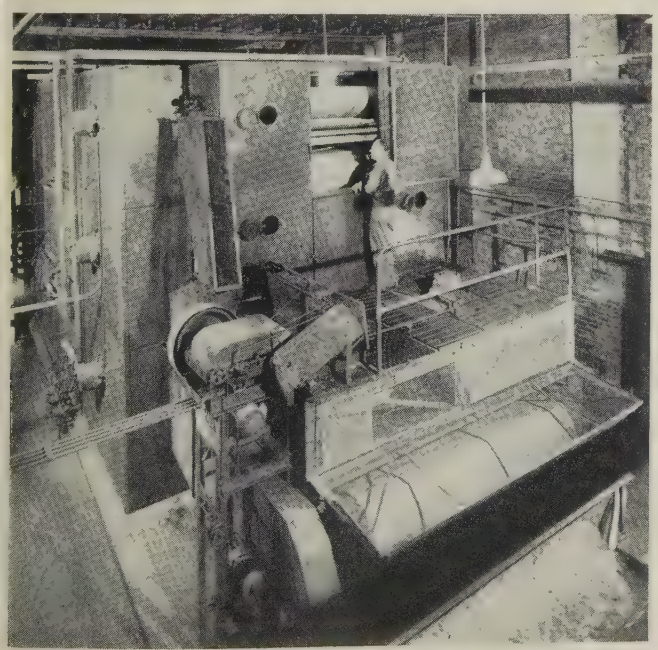
Torrington

Milton E. Berglund has been elected executive vice-president of the Torrington Co., Torrington, Conn., and Theophil H. Mueller has been elected a director of the company.

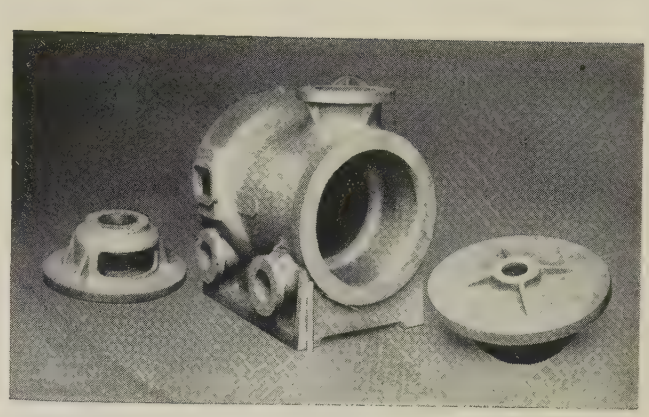
Torrington has published a comprehensive catalog (No. 55), presenting design, application, and use data for 5 types of needle bearings.

Armour

Armour and Company, Chicago, Ill., has reopened its chrome hide glue plant in Chicago, and has installed a new drying process which eliminates impurities from the glue, speeds the process, and assures a better product.



Sheet of glue resembles festoon of paper as it rolls through apron drier where product is dried. Brittle sheet is then broken into pieces before the glue is ground and bagged. Drying process takes only 50 min.



Sutherland stainless steel breaker trap

Sutherland

The Sutherland Refiner Corp., Trenton, N. Y., has introduced an all stainless steel breaker trap for use by the sulphite industry.

Carpenter

The Carpenter Steel Co., Alloy Tube Div., Union, N. J., has issued a bulletin describing the company's B and C super-corrosion resistant tubing and pipe.

J-M

The Johns-Manville Co., New York, N. Y., is beginning construction of a large new insulating board plant at North Bay, Ont., and expects to begin production before the end of 1956. The plant will have an initial annual capacity of 75 million sq. ft. of insulating board, and will cover an operating floor space of about 150,000 sq. ft.

J-M is also planning construction of an asphalt roofing plant and warehouse near Savannah, Ga., to begin production by early Fall, 1956.

Nopco

G. Daniel Davis has been named executive vice-president of the Nopco Chemical Co., Harrison, N J.

Nopco has established a plastics division which will undertake a million dollar expansion program within the next five years, during which time the company anticipates a 25,000% increase in the demand for foamed plastics.

Employees of the Nopco Chemical Co. who have completed 15 years with the company being inducted into the Nopco "Fifteen Year Club." From left to right: J. C. Fleming, C. E. Hildreth, James Carter, J. A. Doyle, D. A. Urquhart, C. P. Gulick, honorary chairman of the board and founder of Nopco; P. O. Palmer, Michael Drabin, Dorothy Shohfi, J. J. Denzler, Ralph Wechsler, president of Nopco; L. E. Rossiter, W. B. Morehouse, assistant vice-president; G. D. Davis, executive vice-president; J. E. Reilly

Nopco has acquired the assets of the Griffin Chemical Co., San Francisco, Calif. Griffin manufactures petroleum sulphonates, naphthenic acid, emulsifiers, plasticizers, and polyvinyl acetate emulsion.

G.E.

General Electric Co.'s Trumbull Components Dept., Plainville, Conn., has issued a booklet (GEA-6286) describing the company's new line of fusable service entrance equipment.

The company's new bulletin GEA-6319, describes current-limiting fuses rated 250 and 600 volts in sizes from 6 to 200 amperes.

Thy-mo-trol, G.E.'s general-purpose, full-wave adjustable-speed drive is described in the company's bulletin GEA-6234.

G.E. bulletin GEA-6331 describes the company's Limitamp high-voltage motor control.

The company has announced a new line of hollow shaft vertical motors designed specifically for the pumping industry, available in ratings of 40 hp. and up, in frame sizes 404 to 6330. Ratings from $7^1/_2$ hp. and up will be available early in 1956.

G.E.'s Low Voltage Switchgear Department has announced that metering and instrumentation current transformers mounted in breaker compartments are now available in 225 and 600-ampere drawout equipments.

The company's Power Transformer Department, Pittsfield, Mass., has announced higher ratings in G.E. Inductrols (dry-type induction voltage regulators).

Hooker

Hooker Chemicals, Ltd., Vancouver, B. C., subsidiary of Hooker Electrochemical Co., Niagara Falls, N. Y., is building a chlorine-caustic soda plant, to begin production early in 1957.

R. Lindley Murray has been elected chairman of the board of Hooker Electrochemical Co., and Bjarne Klaussen is now president of the company.

Hooker is negotiating with officers of Niagara Alkali Co. for a merger of Niagara into the Hooker organization.

George Chynoweth and Joseph J. Lenahan have been appointed field sales representatives for Hooker and Julian J. Boyce has been transferred to Charlotte, N. C., to cover the southeast. James M. Young 3rd has been given technical sales service responsibilities, working from the company's Tacoma, Wash., sales office and plant.

B & O

The Baltimore & Ohio Railroad Co. completed expansion and modernization of its Connellsville, Pa., classification yard recently, at a cost of $1,900,000.

National Adhesives (Canada) Ltd.

The following new appointments have been made by National Adhesives (Canada) Ltd., Toronto, Ont.: Gerald W. Burgoyne, technical service manager; Michael J. Stasko, technical service representative for British Columbia and Alberta; Marc Archambault, technical service supervisor of the Toronto divisions; and Arthur Bourke, technical service supervisor for paper.

Monsanto

The new Fieldsboro, N. J., plant of Monsanto Chemical Co., St. Louis, Mo., when it begins production this Fall, will reduce the delivery time for Mersize and related products by 50 to 75%.

Downingtown

Downingtown Manufacturing Co., Downington, Pa., has appointed the L & O Research and Development Corp., Wayne, Pa., to conduct a basic research related to papermaking.

G. A. Lear, Moore & White

R. F. Amacher, Anheuser-Busch, Inc.

Moore & White

George A. Lear, president of Moore & White Co., Philadelphia, Pa., is in Europe on an extensive business trip of all countries west of the Iron Curtain. The company is establishing sales and distribution outlets in Europe, searching for European-made products needed by the industry in the United States, and exploring what products can be manufactured economically in Europe to supplement the company's present line of equipment.

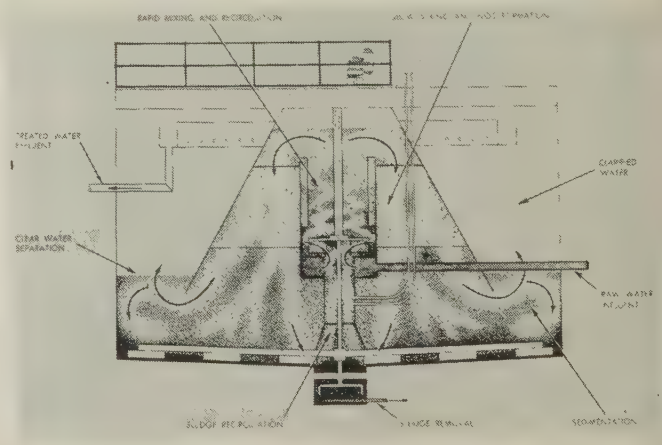
Anheuser-Busch

Robert T. Regan has been appointed eastern region manager, Bulk Corn Products Dept., Anheuser-Busch, Inc., St. Louis, Mo., succeeding R. F. Amacher who is now sales manager of the department.

Graver

Graver Water Conditioning Co., New York, N. Y., has issued technical reprint T-134 entitled "Chemical Reactions in Hot and Cold Treatment Units," and technical reprint T-135, "Design of Water Clarifiers and Cold Process Softeners."

Graver bulletin (WC-118) described the company's new small size deaerating heater.

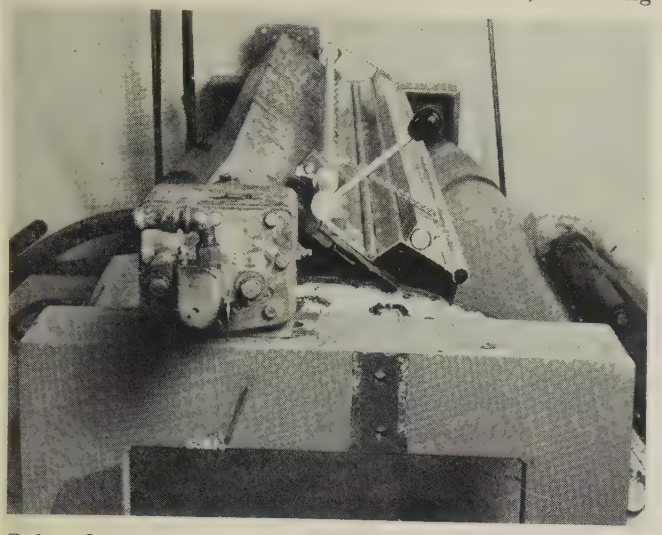


The Graver reactivator

The company has found that problems in water clarification and softening resulting from frequent and fluctuating changes in flow rate and water composition are successfully overcome by certain features of the Graver Reactivator, namely, a variable speed impeller, a separately driven sludge scraper, a low sludge level, and sludge removal over the entire bottom of the reactivator.

LODDING

Lodding Engineering Corp., Worcester, Mass., is offering



Drier doctor with fuzz remover installed but exhaust elbow removed to show cross-section

a Fuzz Remover for carrying away fuzz made by drier doctors.

MINNEAPOLIS-HONEYWELL

Minneapolis-Honeywell Regulator Co. has issued a data sheet (No. 11.12-1), describing two systems for obtaining a sequence timing control.

NATIONAL STARCH

National Starch Products' second polyvinyl resin plant at Meredosia, Ill., is now in operation.

PENNSALT

William P. Drake has been elected president of Pennsylvania Salt Mfg. Co., Philadelphia, Pa., succeeding George P. Beitzel.

BROOKS

Brooks Rotameter Co., Lansdale, Pa., has issued a bulletin (No. 135) describing the newly designed Sho-Rate Purge Meter.

DIAMOND ALKALI

The following new sales and service appointments have been made by Diamond Alkali Co., Cleveland, Ohio: Robert R. Wood, special staff assistant; C. Robert Powell, New York sales; Charles H. Gillespie, Louisville, Ky., area representative; Charles B. Karper, Columbia, Ohio, representative; Louis P. Lambros, Cincinnati sales.

ALLIED CHEM. & DYE

The General Chemical Div., Allied Chemical & Dye Corp., New York, N. Y., will build a new liquid aluminum sulphate plant at Tacoma, Wash. The division recently completed a major addition to its aluminum sulphate plant at Kennewick, Wash.

HUYCK

F. C. Huyck & Sons, Rensselaer, N. Y., has issued a booklet describing 4-D treatment, a new chemical development which toughens wool fibers and stabilizes wool's normal tendency to stretch.

SNELL

A study by W. H. Kanninen and W. L. Hardy, Foster D. Snell, Inc., New York, N. Y., indicates that opaque waxed paper is about twice as effective in reducing the degradation by light of riboflavin in enriched white bread as is cellophane. Copies of the paper are available from Snell.

Snell has published its first Annual Index of market news and statistics for the chemical industry.

OBITUARIES

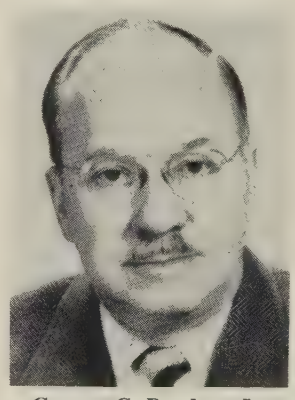
Gerald N. Bates

Gerald Nudell Bates of the Technical Service Dept., Canadian Titanium Pigments, Ltd., Montreal, P. Q., died suddenly on June 3, 1955.

Mr. Bates was born in Aultsville, Ont., on July 9, 1911, and received his masters degree in chemistry in 1933 from the University of Saskatchewan. Following graduation he was employed by Simpson Co. Ltd., Regina, Sask. In 1934–35 he was a research chemist for the University of London. From 1935 to 1938 he was engaged in sales for Canadian Industries, Ltd. in Montreal. Since 1938 he was employed by Canadian Titanium Pigments, Ltd.

George C. Borden, Jr.

George C. Borden, Jr., technical director and manager of the coating department of Riegel Paper Corp., died of a heart attack on July 8, 1955, at his home in Milford, N. J.



George C. Borden, Jr.

Mr. Borden was born in Ocean Grove, N. J., on Aug. 26, 1900, and graduated as a chemical engineer from Lehigh University in 1923.

From 1923 until 1937 he worked as a research chemist and works manager of the Trembley Point graphite plant of the American Cyanamid Co. He joined the Riegel Paper Co. organization in 1937 as a development engineer.

Mr. Borden was chairman of the Wax Testing Committee of the Technical Association of the Pulp and Paper Industry.

Arthur Alexander Scott

Arthur A. Scott, secretary of the Pulp and Paper Research Institute of Canada, died in June in Montreal, Que.

Mr. Scott was born in Montreal, Que., on Oct. 10, 1889, and received his masters degree in physics from McGill University in 1913, following which for nine years he was senior demonstrator in physics at McGill.

For eight years he was physicist for the Abitibi Power & Paper Co., Iroquois Falls, Ont., and worked for a few years in the same capacity at the Anglo-Canadian Pulp & Paper Co., Quebec, P. Q., following which he joined the staff of the Pulp and Paper Research Institute of Canada.

Mr. Scott was a member of the Technical Association of the Pulp and Paper Industry since 1929.

TAPPI DIVISIONS AND COMMITTEES

Reports of Activities

Structural Fibrous Materials Committee

R. G. Lacey, Celotex Corp., Marrero, La., has called a meeting of the Steering Committee of the Structural Fibrous Materials Committee for September 5 at Absecon, N. J.

The new equipment for test board formation is in the process of evaluation.

Celotex Corp. and Simpson Logging Co. are completing their evaluations of the new drainage time tester.

A booklet of procedures for testing and evaluation of the coated properties of decorative coated fiberboard was sent to members for comment in April. So far no comments have been received by Subcommittee Chairman E. A. Lauring.

A water vapor permeability tester for insulation board is being developed. Test results have been variable and further work to eliminate the causes of variation is in progress.

A request for a research appropriation for a study of edge nail strength and racking strength of wood fiber sheathing is in preparation.

The committee's modified Baumgarten sphere for light reflection measurement is being evaluated by Celotex Corp. in Chicago.

Test data on a new proposed method for consistency measurement are being obtained from 16 mills.

No report has been received from the subcommittees on Rate of Drying of Insulating Board and Relation of Finished Board Properties to Wet Lap and Stock Characteristics.

J. J. Perot, *Secretary*

Nonfibrous Materials Testing Committee

Adhesives Subcommittee

A meeting of the Testing Adhesives Subcommittee of the Nonfibrous Materials Testing Committee was held on May 25, 1955, at TAPPI Headquarters, 155 E. 44th St., New York 17, N. Y.

Members present:

Joseph P. Carey, Dennison Mfg. Co.
Carl Erikson, Arabol Mfg. Co.
Walter G. Kunze, Le Page's, Inc.
Larry J. LaBrie, Morningstar, Nicol, Inc.
Leonard B. Lane, Armour and Co.
Ray J. Lodge, The Borden Co.
Otto H. Miller, Beech-Nut Packing Co.
Robert H. Sams, Philadelphia Quartz Co.
William W. Sederlund, National Starch Products

A. B. Crowell was elected chairman and L. B. Lane was elected secretary.

Mr. Sederlund led a discussion on the purpose of the Adhesive Committee and its aims. The thoughts boiled down to the fact that the committee is to render service to the manufacturers and users of paper with emphasis on the latter group. As a service unit, efforts should be directed toward methods of testing that would be most helpful and significant to these adhesive consumers. It followed, therefore, that earliest considerations would be centered on performance tests rather than on quality or evaluation tests of the adhesive *per se*, but not without the knowledge that in some cases both types of tests might be desirable.

Cognizance was given to work already conducted on adhesives by the Boxboard Committee, D-14, and Packaging Institute, and a warning was signalled about overlapping efforts, especially about covering that ground on which information already had been published. This led to the passing of a motion that each member would mail to the secretary before June 30, a bibliography of pertinent information on test procedures for compilation and dissemination to all members. These references will include:

Government Specifications
American Boxboard Association
ICC Freight Classifications
Packaging Institute
ASTM–D-14
Etc.

Besides the name of the reference, the source and any other data which will aid in procurement shall be included.

Upon the request of the chairman, each person presented ideas on performance tests adaptable to his own adhesives or to his own adhesive applications. The condensed list follows:

Proposed Program

(Projects listed in order of importance)

1. Bonding quality
   (a) Fiber tear
   (b) Strength
2. Speed of set
3. Open time
4. Drying speed
5. Tack
   (a) Initial
   (b) Range
6. Humidity effect on resultant bonds
   (a) Blocking
   (b) Staining
   (c) Bonding
      (1) High humidity
      (2) Low humidity
   (d) Deformation (wrinkling)
7. Resistance to:
   (a) High temperature
   (b) Low temperature
   (c) Water
   (d) Grease
   (e) Solvents
   (f) Sterilization
   (g) Mold and microorganisms
   (h) Vermin
8. Remoistening characteristics
   (a) Speed
   (b) Tack
   (c) Final adhesion
   (d) Resistance to wash-off
   (e) Remoistenability on accelerated aging
9. Reducing substances.
10. Stability in solution.
11. Mechanical stability (liquid latex).
12. Machining or operating characteristics (cottening, throwing, etc.)
13. Foaming
14. Chemical stain
15. Flexibility
16. Penetration (cellophane and paper).
17. Oxidation resistance (copper poisoning-latex)

Consideration was given to a plan to learn more about laboratory facilities of both paper users and manufacturers so as to "tailor" the tests to the ability of the average plant to conduct them. With this as a starting point, an idea evolved of the possibility of submitting to all TAPPI members, through *Tappi*, the foregoing list of 17 tests for opinions on their relative importance from the consumer standpoint.

Obviously, no action could be taken without the necessary consultations.

A discussion of an instrument to measure tack terminated by a request of Lane to investigate and report at next meeting.

Attention was called to the desirability of papers for the forthcoming Testing Conference. Mr. Carey, of Dennison Manufacturing Co., stated that his company might be willing to submit a paper on "blocking," which covers an apparatus for measuring the blocking effect of resin-type adhesives. Mention was made of the Fifth Testing Conference to be held at the Sheraton-Kimball Hotel, Springfield, Mass., on Sept. 28–30, 1955.

A discussion followed regarding the next meeting of the committee. It was the concensus that New York would be the logical place, but no date was set. When a decision is reached on this latter point, an official notice will be issued.

L. B. Lane, *Secretary*

Pulp Testing Committee

A meeting of the Eastern Section of the Pulp Testing Committee was held on May 13, 1955, in Cincinnati, Ohio with the following members in attendance, H. A. Smith, Chairman, F. A. Delforge, C. E. Brandon, H. Caldwell, R. R. Chase for G. C. Kimble, and F. L. Rastatter.

Reports on Projects

1. *Stock Consistency.* Work on this project is continuing, and additional checks are being made where the data appear erratic.

2. *High Range Freeness Tester.* The units manufactured by Thwing-Albert are being tested in various mills. R. R. Chase reported that his laboratory is expecting a trial unit and would report on their findings.

3. *Handsheets for Flat Crush.* It was pointed out that caliper is very important for this purpose. R. R. Chase and H. Caldwell will report on their companies' experience at the Testing Conference in Springfield, Mass., September 28–30. A discussion was held as to whether the greater pressure required to produce a lower caliper should be used for all board testing. It was agreed that this test is of great importance, and suggested that the steering committee be requested to advise as to how this question should be handled.

4. *Reference Pulp.* It was reported that the standard reference pulp program was progressing satisfactorily. The members felt that samples should be sent to a number of interested people for testing, and the results analyzed before wide distribution of the pulp is made. It was suggested that the Statistics Committee be asked to help set up the procedure so that the results will be susceptible to statistical analysis.

5. *Dirt Count, T213 m-43.* Responses to the questionnaire on this method were too erratic to permit statistical analysis. The questionnaire should include information on types of pulp, whether bleached or unbleached, type of wood, and form in which sample is obtained (slush, lap, or dry).

6. *Pulp Evaluation.* Messrs. Smith and Caldwell suggested consideration of the Mead Laboratory Refiner as an alternate method of testing pulp strengths. It was reported that this instrument gives easily reproducible results with little or no drift. The refining time may vary somewhat but the testing time is very short. The results compare well with mill results using claflins or jordans.

Mr. Delforge reported interesting work using a Waring Blendor as a laboratory beater. The values obtained were somewhat different but the trends were the same as for the Valley beater. Beating time was the same or slightly longer. The Blendor tends to develop less burst and much more tear than the laboratory beater for the same freeness. Its reproducibility is good. Changing the blade makes an appreciable change in the beating action.

7. *Miscellaneous.* R. R. Chase suggested that there is a need for a yield test suited to high-yield pulping. The Cowles and Dynapulper methods were mentioned, and it was pointed out that the method should be suitable to control cooking and possibly bleaching as well.

E. L. Rastatter, *Secretary*
Eastern Section

Semichemical Pulping Committee

The annual meeting of the committee was held at 2:00 p.m., Feb. 21, 1955, under the chairmanship of J. N. Mc Govern with the following present:

S. R. Parsons, Consolidated Water, Power & Paper Co.
C. N. Rogers, Sonoco Products Co.
R. R. Chase, Union Bag & Paper Corp.
E. H. Shriver,* Mead Corp., Chillicothe, Ohio
J. S. Hart,* Pulp & Paper Research Institute of Canada
D. J. MacLaurin,* Institute of Paper Chemistry
R. G. Knechtges,* American Box Board Co.
W. T. Butler,* Abitibi Power & Paper Co.
W. E. Kaley, Armstrong Cork Co.
John Baymiller, Armstrong Cork Co.
M. Nossaman, American Box Board Co.
Paul Trout, Waldorf Paper Products Co.
D. L. Voigts, American Box Board Co.
R. H. Rasch, Hammermill Paper Co.
Tore H. Nevrell, A. B. Billingfors-Langed, Sweden
J. E. Copenhaver, Sonoco Products Co.
Robert P. Green, Champion Paper & Fiber Co.
T. B. Kuhe, Crossett Paper Mills
J. A. Staidl,* Camp Manufacturing Co.
W. H. Flanagan, Graver Tank & Mfg. Co.
Roy Traver, Camp Manufacturing Co.
Keith E. Bradway, Camp Manufacturing Co.
J. H. Symes, National Container Corp. of Virginia
W. W. Marteny,* National Container Corp. of Wis.
George W. Mead III,* Consolidated Power, Water & Paper Co.
C. K. Textor,* Bauer Brothers Co.
G. A. Balko, Richmond Pulp & Paper Co., Ltd.
G. A. Franklin, Ontario Paper Co.
Carl W. Hardesty, Mead Corp., Lynchburg, Va.
C. W. Converse,* Sprout, Waldron & Co., Inc.

The minutes of the previous meeting, Feb. 15, 1954, were accepted.

Equipment Survey (J. E. Sapp, Subcommittee Chairman). D. J. MacLaurin praised the semichemical pulp mills for their wholehearted cooperation in the presentation of the equipment survey. The equipment survey has been completed and published as TAPPI Special Report No. 400.

The work of this subcommittee is completed and it is dis-

* Semichemical Pulping Committee member.

Meeting of the Semichemical Pulping Committee during the 40th Annual Meeting of TAPPI

banding. A vote of thanks was given the subcommittee for its valuable contributions.

Standard Terms (C. K. Textor, Subcommittee Chairman). The standard terms developed by the subcommittee were approved by 17 out of 19 committee members. The terms have been submitted to the Pulp Manufacturing Division Chairman. They are now being put into form for submission to the TAPPI Standards Committee, by the TAPPI headquarters staff.

Semichemical Pulping Measures (R. W. Brown, Subcommittee Chairman). R. H. Rasch reported for Mr. Brown. The survey on pulping measures has been published as TAPPI Special Report No. 403.

Bibliography (J. N. McGovern, Subcommittee Chairman). The original appropriation request for bibliographic purposes apparently was lost somewhere along the line, but meantime The Institute of Paper Chemistry has brought its previous comprehensive bibliography up to date and will issue it in 1955.

Newsnote Subcommittee (C. W. Converse, Subcommittee Chairman). Three issues of the Newsnote were sent out during 1954 to committee members.

The meeting turned to new business. Mr. McGovern asked the committee for their thoughts on whether or not a subcommittee on spent liquor recovery could render useful services. W. W. Marteny stated that some information is available on spent liquor recovery but the information on the Institute of Paper Chemistry process which is in operation in his mill has not been released yet. C. N. Rogers representing R. G. Coker suggested that the subcommittee survey the various recovery systems available and analyze them. He reported that his company has just secured a patent on the production of acetic acid from neutral sulphite semichemical spent liquor.

W. W. Marteny recommended a subcommittee on stock preparation of semichemical pulps. He pointed out the semichemical pulps have their own strength development characteristics and that the current practice of treating them like fully cooked pulps did not give best results. The study should include fiberizing and refining studies. The conditions for refining various grades of semichemical pulp, the effects of consistency, temperature, etc., should be explored. The work should be done under a research grant.

G. W. Mead III agreed that any such study must start with fiberizing since this operation affects the fiber refining characteristics profoundly.

C. W. Converse recommended a subcommittee on materials of construction, pointing out that unsatisfactory materials of construction cost neutral sulphite semichemical pulp mills a tremendous sum of money each year. R. G. Knechtges agreed with the value of such a study. J. A. Staidl suggested that this study be undertaken by the committee only if the engineering division did not feel that one of their committees could undertake it. The decision of the committee was that C. W. Converse would contact the general chairman of the engineering division and discuss the matter with him, then report to the committee chairman.

J. N. McGovern suggested a subcommittee on pulping procedures. The committee would study all of the semichemical pulping procedures from the chemical viewpoint. Both chemical and operating information would be compiled. J. A. Staidl recommended a permanent committee for this purpose because there is a great change going on in the semichemical pulping processes at this time and the committee will have much to do in keeping up with these improvements and with the new developments.

J. N. McGovern suggested that a policy subcommittee be set up to act as an executive committee and also as a program committee. This committee would consist of the chairmen of the other subcommittees.

The foregoing activities having been proposed, Mr. McGovern asked for expressions as to which of the activities proposed would contribute the most to the industry and should, therefore, be undertaken. J. S. Hart recommended that the spent liquor and pulping procedures subcommittees be combined.

Mr. McGovern asked the committee for their views about participation of the committee in other meetings. The Alkaline Pulping Committee has asked the Semichemical Pulping Committee to sponsor one session of the Alkaline Pulping Conference. Four technical papers will be required. The committee needs eight to ten papers per year for a full participation. J. S. Hart stated that the semichemical pulping industry is large enough to provide at least that many papers each year. C. K. Textor favored participation with the Alkaline Pulping Committee. Some semichemical pulping operations impinge on groundwood, acid sulphite and alkaline pulping methods, he pointed out and we should cooperate with all of the pulping committees. A motion was made by C. K. Textor that the Semichemical Pulping Committee cooperate with the Alkaline Pulping Committee in presenting four papers for an Alkaline-Semichemical Pulping Conference. Motion was seconded by J. S. Hart and carried unanimously.

The Policy Subcommittee will work out details of the 1956 annual meeting. More room is needed. Holding the committee meeting on Monday morning of TAPPI week was suggested for consideration.

D. J. MacLaurin stated that The Institute of Paper Chemistry Bibliography of Semichemical Process has been brought up to date as of the middle of 1954 and that it will be ready in about three months.

Mr. MacLaurin reported that his group at The Institute of Paper Chemistry is working on the Rheology of Semichemically Cooked Wood under a grant of the Fundamental Research Committee.

C. W. Converse, *Secretary*

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High Voltage D. C. Testing of Cables and Cable Fault Location*

B. J. NANKERVIS

THE Dow Chemical Co. has located at Freeport and Velasco, Tex., two large plants for manufacturing of chemicals and magnesium metal. Total power requirement for the plants is presently about 500,000 kw. This power is generated at Dow power plants and is distributed by a 15-kv. power distribution system employing aerial cables. The cables, with only several exceptions, are varnished cambric insulated, nonmetallic sheathed, protected with bronze interlocked armor overall. It is the purpose of this paper to discuss our experiences with high voltage d.c. testing of the aerial cables and methods used to locate cable faults.

Construction of the plant facilities started in 1940, and growth during the periods of 1940–43 and 1947–54 has been rapid. As a result the power distribution system has expanded so that the aerial cable system now has over 39 miles of 15-kv. cables. The cable conductor sizes are, for the most part, 3/c, 500 MCM; 3/c, 700 MCM; 1/c, 2000 MCM; and 1/c, 2500 MCM. Figures 1 and 2 show two views of the aerial cable installations.

This distribution system has not been entirely free of electrical troubles. The 1940–44 aerial cables had several failures in 1945. A few more occurred in 1946 and by 1947 two feeders, which had been out of service for several years and were then placed back in use, started failing too frequently. Most of the failures were found to be due to the absorption of moisture into the insulation due to defective jackets employed in the early cables. The cable manufacturer was consulted and a d.c. test set was made available by the City Public Service Board of San Antonio, Texas. The d.c. test set was used to break down the weak sections of the two feeders that were giving trouble, and the sections that tested satisfactorily were combined to make one feeder. This feeder did not fail again in 1947 and operated until replacement cable could be obtained and installed.

METHOD OF TESTING CABLE

As a result of this test experience, The Dow Chemical Co. purchased a d.c. test set in 1948. This set is a half-ware rectifier with a capacity of 100 milliamp. and a voltage of 50 kv., but is not designed to deliver rated current and voltage at the same time. The test set is mounted in a house on wheels as shown in Fig. 3. In the 6 years the set has been in use, over 1000 tests have been made on cable For several years tests were made only after a cable had failed. These were used to determine if sufficient amount of defective cable had been removed prior to splicing in a new section, and to test the repaired cable before returning it to service. The tests were found to be of such value that all new cable installations are now given an acceptance test before placing in service; and, when possible, cables are given an additional proof test once a year. In the early testing it was deemed advisable to disconnect cable terminations from current transformers and switchgear before making d.c. tests. This required considerable taping time before and after the tests, and we have since decided this is not always necessary. We no longer disconnect current transformers or switchgear before making d.c. tests at 30 kv. unless the equipment can readily be disconneced by means of switches.

The test voltage used for 15-kv. grounded neutral varnished cambric insulated cable has, until this year, been 30 kv. d.c. for new and old cables. Recently we started making acceptance tests of new cable at 35 to 50 kv. d.c., depending on the manufacturers' recommendations. This test is made for a period of 5 min. and the leakage current carefully noted during the test.

A number of factors influence the amount of leakage current that will be measured on a cable and a number of excellent papers have been written on this subject. With a good cable we have found that a slight decrease in leakage current will occur during the first several minutes of test and the current will then hold steady for the last minute or two of test. With a poor cable the decrease in current may not occur, and cables in which an increase in current occurs during the test are usually sure to fail on further testing. It is this increase of leakage current that we watch. On many poor cables the leakage current may be steady for several minutes and then fail with no noticeable rise of current before the failure. The 5-min. period seems to be a minimum test time for picking out defects.

Fig. 1. Fifteen-kilovolt aerial cables at Dow Chemical Co., plant B, Velasco, Tex. View is of main cable run and shows self supporting steel corner structure

EXAMPLES OF DEFECTS FOUND

In addition to cable defects we have found troubles in potheads, splices, and switchgear when making d.c. tests. The following cases are examples of failures found by means of d.c. testing:

March 7, 1950. A substation feeder breaker opened due to ground relay action. The feeder was re-energized and stayed energized. On March 8, 1950, the feeder was removed from service for testing. Insulation resistance at 2500 v. and cor-

B. J. NANKERVIS, The Dow Chemical Co., Freeport, Tex.
* Contributed by the Electrical Engineering Committee.

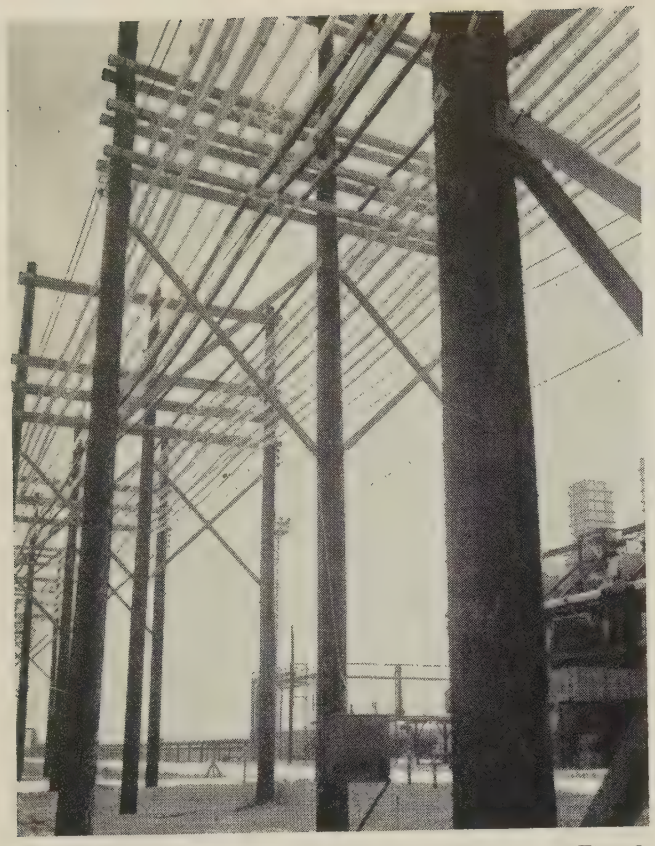

Fig. 2. Fifteen-kilovolt aerial cables shown in Fig. 1. View of three-pole structures used throughout plant

rected for temperature and length was 7.4, 9.0, and 21.4 megohms. The feeder was then tested with direct current and broke down at 20 kv. The trouble was found in a splice.

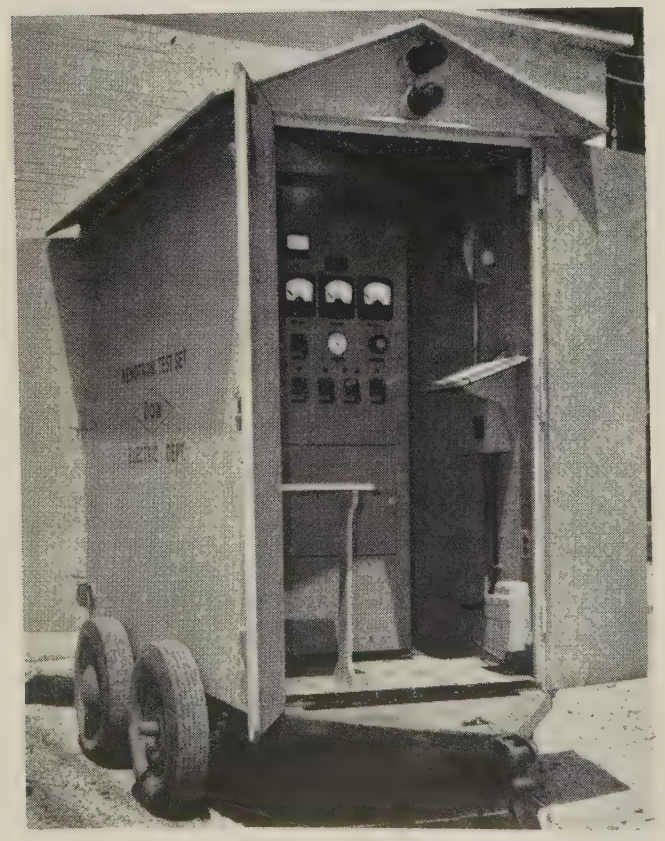

Fig. 3. Fifty-kilovolt d.c. test set mounted in a four-wheel trailer for outdoor use

Compound from the splice sealed the fault so that location of the fault would have been difficult to find without a high test voltage.

Sept. 24, 1951. An acceptance test of three, 1/c, 2500 MCM, 15-kv. cables 3150 ft. long was made. Insulation resistance, not corrected for temperature or length meggered at 2500 v. was 48, 43, and 46 megohms. On d.c. test, *X* phase broke down at 15 kv. *Y* and *Z* phases checked 0.87 and 0.75 milliamp. leakage at 30 kv. The *X* phase fault was found to be a small hole, apparently caused by rolling the reel of cable over a protruding nail during construction.

Jan. 25, 1953. An acceptance test was made of three, 3/c, 700 MCM, 15-kv, cables 4345 ft. long. The *Z* phase of one cable section failed during the 5-min. test. Failure was found to be not far from a pothead. It was due to rough handling of the cable during installation.

May 5, 1953. A pothead at a rectifier station was repaired due to an oil leak. On test, one phase of the cable failed at 20 kv. d.c. The failure was found to be in the pothead and was due to overheating while melting out the compound.

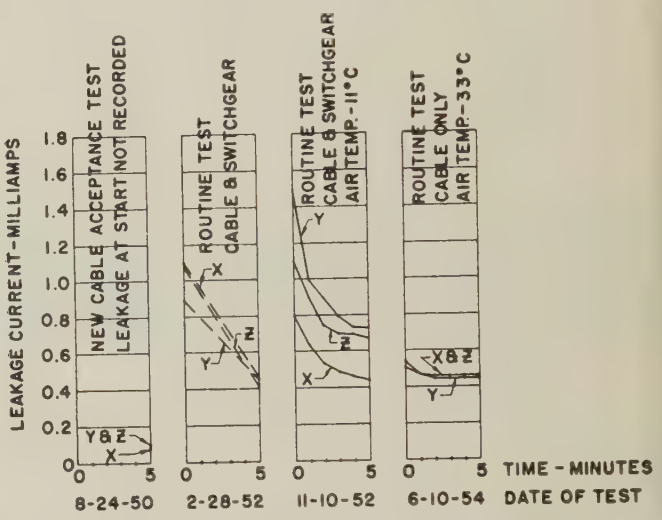

Fig. 4. D.c. test record feeder H-2, 3-1/C 2250 MCM, 21/64-in. V.C., P.V.C. jacket, bronze armored aerial cable, 1770-ft., 30-kv. test voltage

The cable was reinsulated and the pothead remade. On the next test the cable broke down again at 20 kv. The failure was 2 in. below the pothead and was caused by overheating the insulation while soldering the cable armor.

May 10, 1953. An acceptance tests of three, 3/c, 700 MCM, 15-kv. cables 6600 ft. long was made. One cable failed at 17,000 v. d.c. The trouble was found to be due to a manufacturing defect.

Aug. 28, 1953. During routine inspection of a substation three, 5-kv, 50-ft. vertical cables were found to have high leakage on d.c. test. The trouble was found to be due to defective workmanship when the outdoor potheads were made. The substation was $1^1/_2$ years old at time of test.

Sept. 23, 1953. During inspection of a substation high d.c. leakage was obtained on test of transformer cables. It was found that water had stood several inches deep at various times in an air filled pothead compartment and had leaked through a pothead into the cable. The defective cable was replaced and drain holes drilled in all similar pothead compartments. This substation was 11 years old at time of test.

EVALUATION OF TESTS

The purpose of most cable tests is to determine the condition of the cable. With new cable we have had little difficulty doing this, as a defect, when encountered, is usually

found in one location and the rest of the cable will be satisfactory after the defect has been removed.

As cables age the need for evaluating the condition becomes more necessary and the evaluation becomes more difficult. This is, of course, true with all insulating materials and considerable research has been done along these lines for a number of years. Power factor testing is an accepted test for evaluation of cable. However, our cable sizes and lengths and design are such that we question the ability of this test to give the information needed, since the results are an average value for an entire circuit and give little indication of a weak point. However, we have started making power factor tests on short cable sections removed from service as an additional guide to the condition of the cable.

After reading of the experiences of others with d.c. testing, we started keeping graphs of each cable leakage current. The condition of a cable can be estimated by comparing the leakage currents over a number of years. The leakage current should not change appreciably from year to year; however, allowances must be made for different cable temperatures at time of test.

Figure 4 shows a 4-year record of a cable that appears to

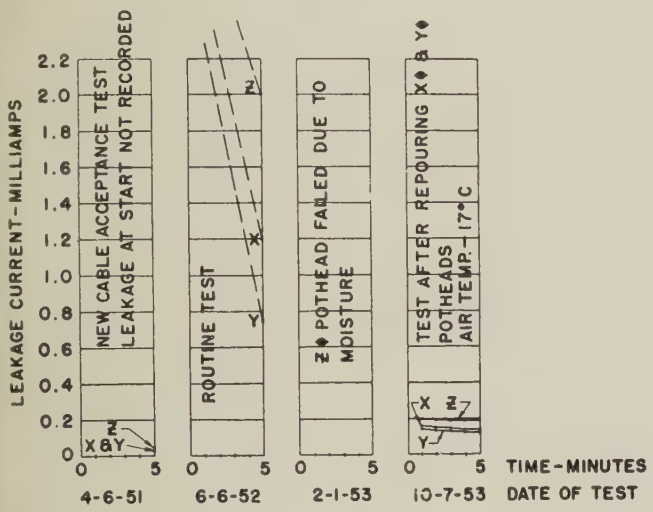

Fig. 5. D.c. test record feeder H-22, 3-1/C, 2500 MCM, 21/64-in. V.C., P.V.C. jacket, bronze armored aerial cable, 1770-ft., 30-kv. test voltage

be in good condition. Figure 5 is a 2½-year record of a cable on which a pothead failed after 22 months operation. The leakage currents were appreciably lower on a test following overhaul of the potheads.

FAULT LOCATION

A number of devices and schemes have been developed to simplify the problem of fault location. With aerial cables and slow relay clearing time it is no problem; one or more of the conductors will have extensive damage at the fault and can be found by patrolling the line. With fault clearing time of the order of nine cycles the damage will be small and can not readily be found. Figure 6 is of a typical phase-to-ground fault that occurred on a single conductor 2000 MCM cable. The hole burned through the insulation and armor is about ½ in. in diameter.

Following a cable failure we patrol the line and look for a smoked spot. If this does not reveal the trouble the high voltage d.c. test set is connected to the cable and used to carbonize the fault and thus lower its resistance. We then use the condenser discharge method for locating the fault. This is a well known method in which a spark gap is set to control the discharge of a condenser through a cable fault and to ground. The discharge across the fault will cause a loud

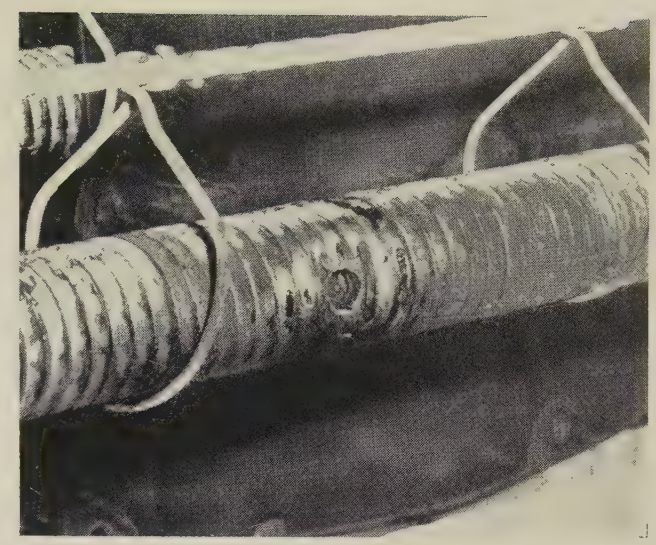

Fig. 6. A typical phase-to-ground fault in an aerial bronze armored cable with 800-amp. maximum fault current and nine-cycle clearing time

noise that is effective about 25% of the time for location of the fault. When this is not successful, we connect three 5-kva. transformers between the cable and ground and burn the fault until it starts smoking. By means of switches the voltage available for burning the fault can be lowered from 6900 in seven steps down to 383 v. Figure 7 shows a trailer that contains the condensers, spark gap, power supply, and transformers used for fault location. With this equipment we can usually locate a cable fault in our aerial cables within several hours.

We believe that better methods of fault location are in use and we are in the process of investigating this further.

SAFETY PRECAUTIONS

With high voltage testing considerable care must be exercised to protect personnel and equipment. After obtaining clearance from our power dispatcher we place a man at each end of the cable to stand guard and prevent anyone from working near the terminations. Provision has to be made for at least 4 in. air gap around the bushings under test to prevent an arc from jumping to other equipment and making other circuits hazardous to personnel and also causing equipment damage due to overvoltage. After the high voltage test has been completed a ground is placed on the cable con-

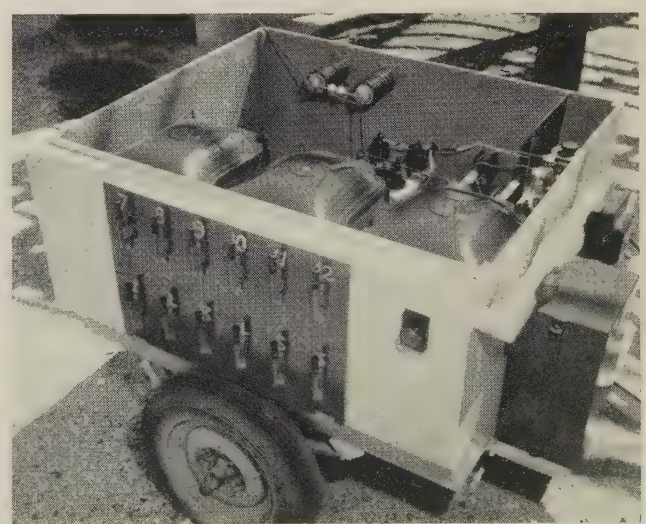

Fig. 7. Trailer containing equipment used for location of aerial cable faults

ductors and left for 5 min. or longer. If this is not done the voltage of a cable conductor may build up to dangerous value after being discharged for only a short period.

Following a splice or pothead job care must be taken not to apply a high test voltage until the compound has cooled sufficiently. At elevated temperature the insulating compounds we use have low dielectric strength and we have had several failures from testing while the insulating compound was too hot.

CONCLUSIONS

We have found high voltage d.c. testing to be of considerable value for acceptance testing of new cables and routine testing of older cables. By means of this testing we have found cable and termination defects that were repaired during planned shutdowns. Had these defects not been found they could have caused power failures that would have been more difficult to repair and could have been very costly due to loss of production.

LITERATURE CITED

Hill, G. Leslie, "Testing of High Voltage Cables With the Kenotron Set," Pacific Coast Electrical Association, Underground Systems Committee, May 15, 1932.

Fenn, W. D., and Gray, L. A., "Cable Field Testing and Fault Location," *Electrical World* (Aug. 19, 1944).

Parker, John C., "Cable Test Program Uses Portable Kenotron Set," *Electrical World* (Feb. 3, 1944).

Nelson, Roy A., "New Methods Simplify Fault Location in Portable Power Cables," Mechanization, April, 1951.

Robinson, D. M., "Dielectric Phenomena in High Voltage Cables," 1936, Chapman and Hall.

Presented at the Seventh Power Distribution Conference, University of Texas, Austin, Tex., Oct. 25–27, 1954.

New Steam Plants in United

Company	*Mill location*	*Boilers*														
		Number	*Startup*	*Pressure, p.s.i.g.*	*Temperature, °F.*	*Capacity, continuous thsd. lb./hr.*	*Furnace volume, thsd. cu. ft.*	*Superheater*	*Economizer*	*Air heater*	*Dust collector*	*Forced draft fan drive*	*Forced draft fan volume control*	*Induced draft fan drive*	*Induced draft fan volume control*	*Combustion control*
Great Northern Paper Co.	East Millinocket, Me.	2	7-54 7-55	1300	855	330	22	C,P	..	R	...	M	D	M	D	A
Minnesota & Ontario Paper Co.	International Falls, Minn.	1	3-56	1290	800	240	14	C,P	I	R	M	M	VC	M	S	A
International Paper Co.	Panama City, Fla.	1	9-54	1250	950	330	13	R,P	S	T	M	M	D	T	S	A
Crown Zellerbach Corp.	Port Angeles, Wash.	1	7-54	1000	900	170	7.2	I,P	..	T	...	T	VC	T	S VC	A
Gaylord Container Corp.	Bogalusa, La.	1	6-54	875	825	250	21	C,P	I	Stm	M	M	D	M	D,S	A
Gaylord Container Corp.	Bogalusa, La. (Recovery)	1	6-54	875	830	142	14.5	C,P	I	Stm	E	M	D	M	D,S	A
Rome Kraft Co.	Rome, Ga.	5	9-54	900	825	750 Total	...	C	I	T	M,E	M	D	M	D	A
Mead Corp.	Chillicothe, Ohio	1	4-55	875	835	250	...	R,P	..	R	M	M	VC	MT	S VC	A
Bowaters Southern Paper Corp.	Calhoun, Tenn.	2	5-54	875	825	150	11	C,P	..	T	...	M	VC	M	D	A
Bowaters Southern Paper Corp.	Calhoun, Tenn.	1	5-54	875	825	125	7.1	C,P	..	T	M	M	VC	M	D	PA
Bowaters Southern Paper Corp.	Calhoun, Tenn.	1	5-54	875	825	123	16.6	C,P	I	Stm	E	M	VC	M	S	M
Scott Paper Co., Hollings-Whitn. Div.	Waterville, Me.	1	6-55	850	750	225	13	C,P	..	R	M	M	VC	T	D,S	A
Kalamazoo Vegetable Parchment Co.	Parchment, Mich.	1	11-55	850	825	175	15.8	I,P	..	R	M	M	VC	M	D	A
John Strange Paper Co.	Menasha, Wis.	1	11-54	725	825	165	7.9	R,P	S	..	M	M	VC	M	D	A
Marathon Corp.	Rothschild, Wis.	..	...	..	..	..	...	..	..	..	...	..	..	..	..	..
North Carolina Pulp Co.	Plymouth, N. C.	1	3-55	650	700	250	...	C,P	..	T	M	M	S	M	S	PA
East Texas Pulp & Paper Co.	Evadale, Tex.	1	11-54	650	750	230	...	C	I	T	M	M	VC	M	VC	A
East Texas Pulp & Paper Co.	Evadale, Tex.	1	11-54	650	750	133	...	R	I	R	E	M	VC	M	VC	A
A & P Corrugated Box Corp.	Lawrence, Mass.	1	5-54	650	750	90	...	I,P	..	T	...	M	VC	M	D	A
Rayonier, Inc.	Jesup, Ga.	1	4-54	625	750	110	7.06	C,P	I	T	M	M	D	M	D	A
Rayonier, Inc.	Jesup, Ga.	2	4-54	625	750	120	6.46	R	..	T	E	M	D	T	S	A
St. Marys Kraft Corp.	St. Marys, Ga.	1	9-54	610	750	300	13.5	C,D	..	T	...	M	D	M	D	M
Buckeye Cellulose Corp.	Foley, Fla.	1	6-54	600	750	300	31.1	C,P	I	T	...	MT	VC	T	S	A
Buckeye Cellulose Corp.	Foley, Fla.	2	6-54	600	750	150	12.3	C,P	I	T	E	MT	VC	T	S	A
Buckeye Cellulose Corp.	Foley, Fla.	1	6-54	600	750	97	7.2	C,P	I	T	M	MT	VC	T	S	PA
P. H. Glatfelter Co.	Spring Grove, Pa.	1	6-56	600	650	250	18.5	C,P	..	R	M	M	VC	T	S	A
Southland Paper Mills	Lufkin, Tex.	2	3-56	600	750	175	8.1	C,P	..	T	...	M	D	Pressurized furnace		A
Blandin Paper Co.	Grand Rapids, Minn.	1	11-54	450	675	175	9.4	C,P	I	T	M	M	VC	M	S	A
Downington Paper Co.	Downington, Pa.	1	(Future 3-54	850 450	800 650	195) 150	...	C,R P	..	T	M	M	VC	T	D,S	A
Crane and Co.	Dalton, Mass.	1	1-54	450	750	32	1.2	C	..	..	M	M	D	M	D	A
Chesapeake Corp.	West Point, Va.	..	...	..	..	..	...	..	..	..	...	..	..	..	..	..
Continental Can Co.	Hopewell, Va.	1	10-54	435	650	175	9.73	C,R P	..	T	M	M	VC	M	D,S	A
Lowe Paper Co.	Ridgefield, N. J.	1	9-55	430	660	60	2.38	C,P	I	..	M	M	D	M	D	A
International Paper Co.	Niagara Falls, N. Y.	1	6-54	425	600	60	3.9	C,P	S	..	M	MT	VC	MT	D	A
St. Croix Paper Co.	Woodland, Me.	..	....	..	..	..	...	..	..	..	...	..	..	..	..	..
Albemarle Paper Co.	Richmond, Va.	1	2-55	250	..	30	...	..	..	..	...	M	VC	..	..	A
Bemis Bros. Bag Co.	Claremont, N. H.	2	7-54	225	500	20	1.03	R,P	I	..	...	M	VC	..	..	A
St. Marys Kraft Corp	St. Marys, Ga.	1	10-54	200	..	72	2.97	..	S	..	M	T	VC	T	S	A
Long View Fibre Co.	Los Angeles, Calif.	1	9-54	175	..	15	0.45	..	..	..	...	M	D	..	..	A
	Seattle, Wash.	1	6-55	175	..	10	...	..	..	..	...	M	D	..	..	A
Coos Bay Pulp Corp.	Anacortes, Wash.	1	11-55	160	..	30	...	..	..	..	...	M	D	..	..	A

Superheater: C—Convection, I—Interdeck, R—Radiant, P—Pendant, D—Drainable.
Economizer: I—Integral, S—Separate.
Air heater: P—Plate, T—Tubular, R—Regenerative.
Dust collector: M—Mechanical, E—Electrostatic.
Fan drive: M—Motor, T—Turbine, MT—Both.
Fan volume control: D—Damper, S—Speed, VC—Vane control.

New Steam and Power Equipment for United States Paper Mills—1954*

R. H. SOGARD

STEAM and electric power are important and not inexpensive services in the production of pulp and paper. Their continuous and economical generation are essential to a satisfactory mill operation.

Since the design of a steam or steam-electric plant has a major and inescapable influence on its performance, the Steam and Power Committee felt that a yearly summary of design trends would show what the paper industry is constructing in such plants. Each steam plant is, of course, tailored for its own load, fuel, and water conditions but certain common developments appear. These may be seen in the tabulated data of some 33 mills that supplied the information for 1954. To the long-suffering and questionnaire-ridden individuals who kindly helped, we extend our thanks.

One development which appears is bigness. More than half of the boilers shown are over 150,000 lb. per hr. in capacity, with six units at 300,000 or more. There are five turbine-generator units of over 10 mw. capacity.

Steam pressures are up, with three fourths of the boilers at 600 psig or more and four units in the 1200 psig region. More available energy from higher pressure is of course the reason.

As concerns steam generating unit components, pendant convection superheaters dominate that item. About half

* Contributed by the Steam and Power Committee, Engineering Division, Paper Mill Power Plants Subcommittee, R. H. Sogard, *Chairman.*

States Paper Mills—1954

Fuel				Turbine-generators										Feedwater treatment				Circulating water	
Kind	*Location of source*	*Firing equipment*	*Ash fusion temperature, °F.*	*Number*	*Startup*	*Pressure, p.s.i.g.*	*Temperature, °F.*	*Rating, mw.*	*Controlled extraction, p.s.i.g.*	*No. of uncontrolled extraction points*	*Exhaust pressure, in Hg abs. or p.s.i.g.*	*Generator voltage, kv.*	*Generator rating, mva.*	*Generator cooling*	*Source of makeup*	*Av. makeup, %*	*Type of water treating equipment*	*Deaerating heater max. pressure, p.s.i.g.*	*Source*	*Used in mill process?*
O	...	B	...	1	7-54	1250	825	12.5	200	..	40G	6.9	15.6	H	R	15	IX	40	..	..
C	W. Va.	P	2400	1	3-56	1250	800	6.25	..	..	435G	6.6	7.5	A	R	40	IX	50	..	..
O,W	...	SS	...	1	4-55	1250	950	20	400	1	140G	13.8	25.6	H	W	45	IX	60	..	..
O	Calif.	B	...	..	...	...	..	...	..	..	...	...	...	..	R	33	CC	15	R	Yes
G,W	...	SS	...	1	6-54	850	825	15	165	..	3A	13.8	18.7	H	R	60	CC	35	R	No
B.L.	...	B	...	..	...	...	..	...	..	..	...	...	...	..	..	..	..	..	..	..
3C	E.	P	2500	3	9-54	825	825	17.5	..	..	50G	4.16	21.9	A	R	..	HC	50	R	Yes
2 Liq.	Tenn.							Tot.			150G									
C	Pa.	P	1900	..	...	...	..	...	..	..	...	...	...	..	W	..	IX	25	W	Yes
G	...	..	...	1	5-54	850	825	10	50	..	2.5A	13.8	12.5	A	R	28	IX	5	R	Yes
									150											
W,G	...	..	...	1	5-54	850	825	10	..	..	50G	13.8	12.5	A	..	..	..	..	..	..
B.L.	...	..	...	..	...	...	..	...	..	..	...	...	...	..	..	..	..	..	..	..
C	W. Va.	P	...	1	9-55	825	725	7.5	..	1	120G	4.16	9.38	A	R	25	IX	10	..	..
C	W. Va.	P	2500	1	11-55	850	835	7.5	220	1	2A	4.8	9.38	A	R	25	HC	50	R	No
									50											
C	W. Ky.	SS	2250	1	11-54	725	825	5	..	2	50G	4.16	7.5	A	R	20	HC	5	..	..
...	...	..	...	1	4-54	600	700	4	..	..	35G	4.16	5	A	..	..	..	..	..	..
O,W	...	SS	...	..	...	...	..	...	..	..	...	...	...	..	R	40	IX	40	R	Yes
G,W	...	..	...	1	11-54	600	750	7.5	150	..	50G	13.8	9.38	A	W	40	IX	50	..	..
B.L.	...	..	...	..	...	...	..	...	..	..	...	...	...	..	..	..	..	..	..	..
O	...	..	...	1	5-54	600	750	2.5	..	..	50G	2.3	3.75	A	R	20	IX	50	R	No
O,W	...	..	...	1	4-54	600	750	5	140	..	2.5A	4.16	6.25	A	W	30	CC	60	W	Yes
									60											
B.L.	...	..	...	1	4-54	600	750	5	..	..	150G	4.16	6.25	A	..	..	..	..	..	..
O	...	..	...	1	9-54	600	700	15	120	1	2.5A	13.8	18.75	H	W	49	IX	30	W	Yes
									50											
O	Tex.	..	...	2	6-54	600	750	7.5	150	..	50G	12.47	9.38	A	W	45	IX	10	W	Yes
								6.0					7.50							
B.L.	...	..	...	1	6-54	150	..	1.5	..	..	2A	12.47	1.88	A	..	..	..	..	..	..
W	...	SS	...	..	...	...	..	...	..	..	...	...	...	..	..	..	..	..	..	..
C,O	...	P	2100	..	...	...	..	...	..	..	...	...	...	..	..	..	..	..	..	..
G	Tex.	B	...	2	4-56	590	750	12.5	30	..	3A	6.9	15.63	A	W	15	IX	30	W	Yes
C	Ohio	SS	2200	..	...	...	..	...	..	..	...	...	...	..	..	..	HC	5	..	..
	W. Va																			
...	...	..	...	..	...	...	..	...	..	..	...	...	...	..	..	..	..	..	..	..
C	...	P	2400	..	...	...	..	...	..	..	...	...	...	..	R	30	HC	..	R	Yes
C	Pa.	SS	2800	..	...	...	..	...	..	..	...	...	...	..	L	90	CC	5	..	..
...	...	..	...	1	9-54	450	650	5	..	..	135G	2.3	6.25	..	W	..	HC	10	W	Yes
																	IX			
W	...	SS	...	..	...	...	..	...	..	..	...	...	...	..	R	50	HC	10	R	Yes
																	IX			
C	W. Va.	US	2700	1	9-55	400	750	3	200	..	15G	2.4	3.75	A	W	25	CC	15	..	..
									induced											
C	Pa.	SS	2600	..	...	...	..	...	..	..	...	...	...	..	R	45	IX	7	..	..
...	...	..	...	1	6-55	400	725	7.5	..	1	1.5A	13.8	9.38	A	..	..	..	..	..	..
O	...	B	...	..	...	...	..	...	..	..	...	...	...	..	City	60	IX	5	..	..
O	...	B	...	1	7-54	220	450	0.4	..	..	15G	0.48	0.5	A	R	25	HC	8	..	..
C	Va.	SS	2150	..	...	...	..	...	..	..	...	...	...	..	R	15	IX	7	..	..
O,G	...	B	...	..	...	...	..	...	..	..	...	...	...	..	R	15	IX	7	..	..
O,G	...	B	...	..	...	...	..	...	..	..	...	...	...	..	R	60	CC	..	..	..
O	...	B	...	..	...	...	..	...	..	..	...	...	...	..						

Combustion control: M-Manual, PA—Partially automatic, A—Fully automatic.
Kind of fuel: C—Coal, O—Oil, G—Gas, W—Wood waste, B.L.—Black liquor.
Source: Abbreviation for state.
Firing equipment: P—Pulverized, SS—Spreader stoker, US—Underfeed stoker, B—Burners.
Generator cooling: A—Air, H—Hydrogen.
Water source: L—Lake, R—River, W—Well.
Water treating equipment: CC—Cold chemical, HC—Hot chemical, IX—Ion exchange.

the boilers have economizers, and all but four of these are integral. The tubular air heater is the most popular, although eight regenerative units appear. Practically all of the coal and wood fired units are equipped with dust collectors, with electrostatic units on the recovery boilers. Fully automatic combustion control is shown on practically all boilers reported.

The kind of fuel is of course a matter of location. As in other industries, coal is becoming less important, firing about a third of the boilers shown. Six coal installations are pulverized coal, five are spreader stokers, and one is an underfeed. Several spreader stokers are shown for wood waste.

Of 26 turbine-generator units reported, 18 are back pressure machines, and 8 condensing. Six of the latter show controlled extraction points for process steam. The four largest units are hydrogen cooled.

Ion exchange dominated the water treating field, the table showing 18 such units, with 7 hot chemical plants and 6 cold chemical plants.

If this information compiled on new construction and operation during 1954 is interesting to the members and readers of *Tappi*, it will be repeated for 1955. Comments from *Tappi* readers, addressed to the Editor, will be appreciated.

The Gas Turbine in Southeastern Pulp and Paper Mills*

FREDERICK WIERK and
WILLIAM L. GARLINGTON

In the field of power generation probably no one item has been as quickly and as thoroughly developed as the combustion gas turbine. The purpose of this paper is to explore, in general terms, the possibilities of profitable application of the gas turbine to pulp and paper mills, particularly in the Southeast.

The phenomenal speed with which the gas turbine has been perfected was accelerated by the parallel development, in the aeronautical industry, of both the jet engine and the turboprop, in the operation of which some amazing performance and maintenance records have been established. It is beyond our present scope to amplify those data which may be derived from other literature.

PULP AND PAPER AS AN ELECTRIC CONSUMER

Among major industries, pulp and paper is led only by the aluminum reduction industry in the amount of electric power required per ton of product. In the Western Hemisphere the most of the aluminum reduction industry has been located in Canada, solely to be alongside tremendous hydroelectric developments. This location was selected in spite of the fact that their raw materials must come from remote corners of the world, and the need of tremendous storages dictated by a short navigating season during which those raw materials can be delivered and the aluminum ingots shipped out.

Pulp and paper, however, is most economically produced close to the wood sources which, in this discussion, are the forests of the Southeastern states. In a few mills, at what are now considered "small" tonnages, pulp and paper was produced in the southeast many years ago, but the impressive construction of mills really started in the middle '30's or about 20 years ago; and today there are 88 mills in the Southeastern states producing the staggering amount of about 80,000,000 pounds of cellulosic products per day.

Frederick Wierk, Pulp and Paper Consultant, and William L. Garlington, Electrical Engineer, Reynolds, Smith and Hills, Jacksonville, Fla.
* Contributed by the Steam and Power Committee.

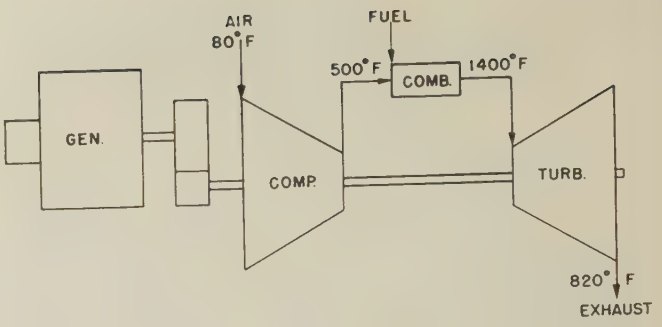

Fig. 1. Gas turbine—simple cycle—single shaft

In addition to impressive kilowatt-hour requirements per ton of product, the manufacture of pulp and paper involves large thermal requirements for cooking pulp, drying paper, calcining lime mud, heating water and air for certain stages in the process, and plant heating. With the exception of lime mud calcining these thermal requirements are practically, and economically, served by steam at various pressures.

The heat-power balance of pulp and paper mills is such that the largest portion, if not all, of the electric power requirements is most economically generated by the mill itself with purchased outside parallel power at a minimum which may be zero.

PRESENTLY EXISTING FACILITIES

The combination of power and thermal requirements led to the development of the double-extraction-condensing steam turbine generator which has come to be known in the trade as a "paper-mill" turbine.

Table I. Typical Data: Gas Turbines, Simple Cycle, 1955

A.	Range of available capacities	1,250–15,000	kw.
B.	Fuel intake	18,500–28,000	B.t.u./kw.-hr.
C.	Air Intake	75– 90	lb./kw.-hr.
D.	Exhaust gas, quantity	81– 97	lb./kw.-hr.
E.	Exhaust gas, temperature	650– 850	°F.
F.	Exhaust gas, thermal energy	14,000–17,500	B.t.u./kw.-hr.
G.	Exhaust gas, oxygen content	16– 18	%

A. Varies among different manufacturers.
B. To G. (inclusive). These data vary with ambient temperature, elevation or barometer, percentage of designed load, and other variables.

In the Southeastern pulp and paper mills most of these turbines range in capacity from 5000 to 15,000 kw. Initial pressures run from 450 p.s.i. 700° FTT up to about 900 p.s.i. 850° FTT. First extraction is somewhere between 150 and 200 p.s.i. and second extraction between 50 and 75 p.s.i. Most of these mills are at tidewater or on a fair-sized stream

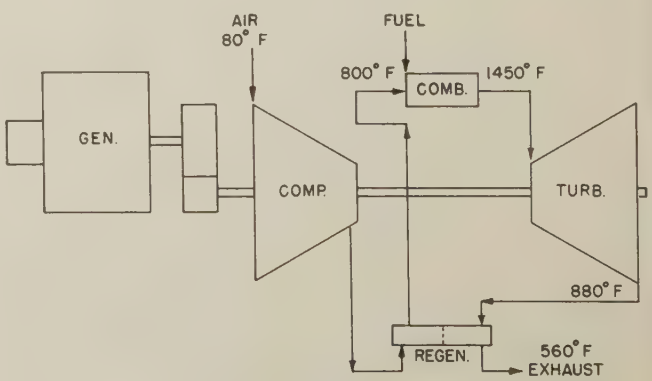

Fig. 2. Gas turbine—regenerative—single shaft

so that vacuum is whatever the water temperature will afford. There are a few cooling towers in use at inland locations.

As the pulp and paper mills here in the southeast have grown in size, complexity, and scope of their operations, the electric power requirements have increased faster than the thermal requirements which, except for the lime kilns, are satisfied mainly by steam.

The different pulp and paper mills involve a variety of thermal gradients. All of them were probably reasonably well engineered when originally built. Initial and extraction pressures were established by original use requirements and, in some cases, dictated by characteristics of then available equipment. Many of the original installations did involve intelligent consideration, by the engineer, of some envisioned future

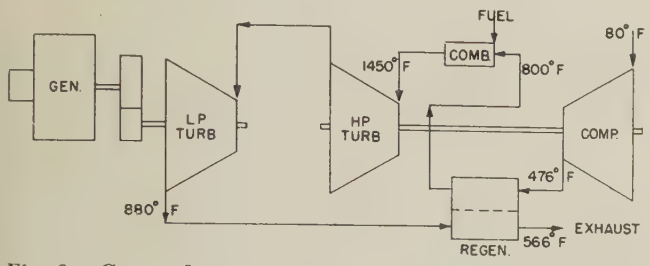

Fig. 3. Gas turbine—regenerative—two shaft—one-stage comp.

expansions and changes. Subsequently, and sometimes with very little warning, the sales department would contrive to change the complexion of the business enough to raise "cain" with the heat/power balance, and the operators would go "nutty" trying to keep up with things. A bleach plant might be added. A hydraulic barker would have to come in. Semi-chemical pulping might be added. Bag plants, box shops, and what have you, were planted on the lot and these same mills found themselves in more or less distress.

These growing mills, which were adequately engineered when built a few years ago, have secured the needed added electric power from increased condensing power generations, from topping, or from increased purchased power.

Some mills have retained power/heat balances that enabled them to simply expand their power and steam generation horizontally at the originally designed thermal gradients for initial and extraction conditions. Such expansion had little effect on overall plant efficiencies.

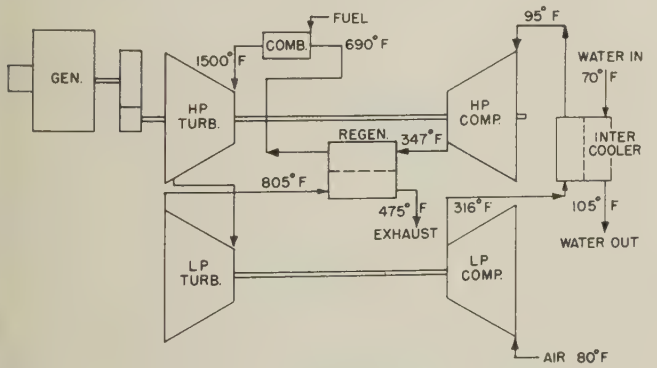

Fig. 4. Gas turbine—regenerative—two shaft—2-stage comp.

Others have obtained some additional power and improved thermal efficiency by expanding their power and steam generation vertically by adding higher pressure boilers and topping units. They had to acquire a quick education in added problems of high pressure operation, starting with boiler feed water treatment, and not entirely ending with turbine control gear, nozzles, and blading.

Another group of mills have secured the needed added electric power from increased condensing power generation or from increased purchased power.

Although increased condensing power generation can be obtained at a favorable turbine water rate, it still throws down the creek too many B.t.u.'s at a thermal gradient from which little or no recovery can be made. Those mills which

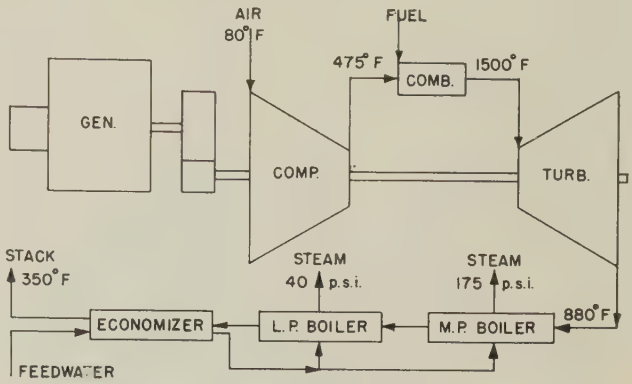

Fig. 5. Gas turbine with nonfired steam boilers

Note: Steam is approx. 11 lb./hr./kw. of G.T. generator output.

simply increased the purchase of outside power did not improve their overall economy but they did eliminate increase in fixed capital investment. Under old excess profit taxing, that was probably justified complacence; but it certainly did not enhance the mills' profit.

THE GAS TURBINE

The combustion gas turbine is fed a considerable quantity of air (approximately 90 lb. per kw.hr.) and a modicum of

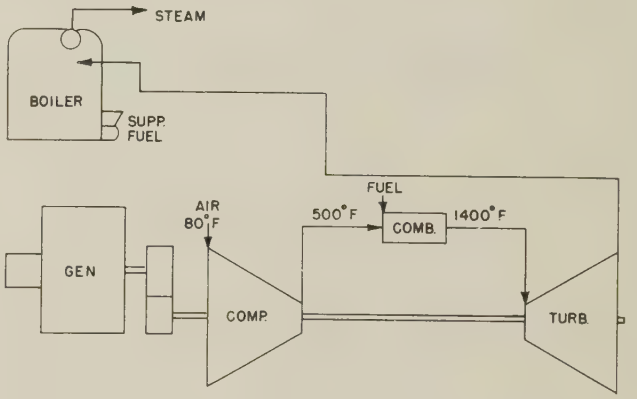

Fig. 6. Gas turbine—with supplementary fired boiler

Note: Steam is approx. 22 lb./hr./kw. of gas turbogenerator output.

fuel which may be liquid or, preferably, gaseous (approximately 18,000 B.t.u. per kw.hr.). It delivers electrical energy and, most fascinating to pulp and paper mill engineers, a nice hot (approximately 800°F.) exhaust discharged at a very useful thermal gradient. This is contrasted vividly with the condensing steam turbine from which an importantly large flood of B.t.u.'s is discharged, usually down the creek, at a thermal gradient from which only small recovery may be made. Some mills have a situation where they can use condenser circulating discharge in the mill as process water, and at least one more northerly mill uses it in a woodyard flume in a way which reduces power on the flume circulator pump and also keeps the flume from freezing during idle winter night shifts.

Table I presents approximate average data covering gas turbines presently available from different manufacturers. These data are not intended to be precise for any given unit but rather to provide food for thought, and simply give a little more than a rough idea of what these units can do. The figures, incidentally, are for simple cycle units and do not show what may be done with regenerative cycles. Our

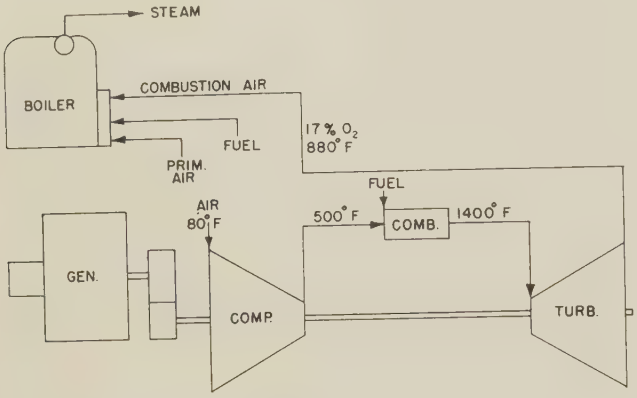

Fig. 7. Gas turbine—giving combustion air to fuel-fired boiler

Note: Steam is approx. 60 lb./hr./kw. of G.T. generator output

reason for tabulating only simple cycle data in this presentation is that we assume the average pulp and paper mill is interested in numerous other things besides kilowatt-hours *per se*. If, in a given situation, some mill needs kilowatt-hours only, a regenerative double-shaft unit with cascaded compressors will be the obvious answer to cheap electric power increments.

Going back to the simple cycle unit, the great variety of possible economic usages of gas turbine exhaust provides the basis from which we can start to evaluate a gas turbine for a given pulp and paper mill situation.

In a pulp and paper mill, gas turbine exhaust may be used in about a dozen different ways, as indicated on the accompanying figures.

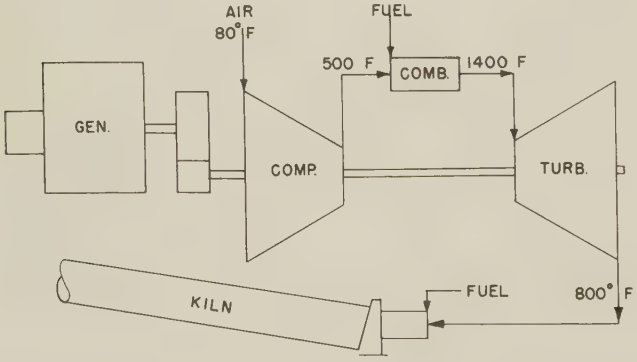

Fig. 8. Gas turbine—exhaust as combustion air in kiln

Figure 1 shows a single-shaft simple-cycle unit. This is probably the paper mill's first choice because of advantages in using exhaust for purposes other than regeneration in the gas turbine itself.

Figure 2 shows exhaust used regeneratively in a single shaft unit. Figure 3 shows regeneration in a double-shaft unit with one compressor on the horsepower, shaft. Justification of the extra shaft lies in the difference in shaft speeds, and vane speeds, possible in this arrangement. Figure 4 shows regeneration in a double shaft unit with part of the compression done on each shaft. In larger units the staging of the compression, with intervening intercooler, justifies the added complexity.

If a mill is rather large, requires *only* kilowatt-hours, and at the same time is otherwise burning very little prime fuel, any of the regenerative schemes shown in Figs. 2, 3, and 4 may be the most economic source of the needed electric energy. In most cases this would, however, be questionable since there is almost always enough prime fuel consumed which can be replaced by gas turbine exhaust with a reduction in the cost of the gas turbine installation.

Figure 5 shows gas turbine exhaust used to directly produce steam in nonfired boilers. This arrangement can produce steam up to 175 p.s.i. in one non-fired boiler and, if desired, steam at some lower pressure at the same time in a cascaded

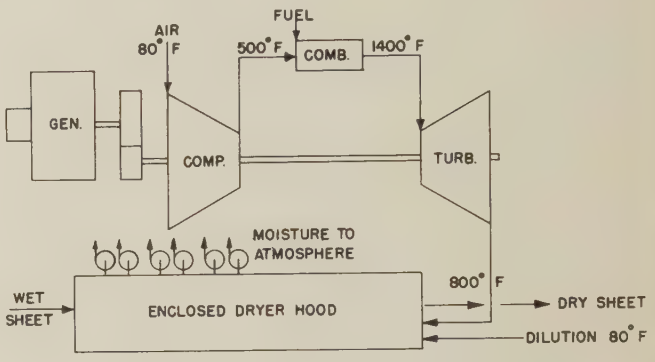

Fig. 9. Gas turbine—exhaust drying pulp or paper

arrangement of another non-fired boiler. This may be exceedingly useful if either or both extraction points in the steam plant are up to capacity.

Figure 6 shows gas turbine exhaust used, as a source of heat, in a supplementary-fired boiler. This arrangement might well be preferred in many mills. The supplementary fuel may be either solid, liquid, or gaseous. The boiler may, in fact, be an existing boiler.

Figure 7 shows gas turbine exhaust used as combustion air in a fuel-fired boiler. This eliminates considerable F.D. fan power and will reduce fuel consumption to the extent of the heat in the exhaust gases which, it may be noted, run high enough in oxygen (16 to 18%) to be useful for this purpose. Choice between Fig. 6 and 7 must be based on careful study of the existing situation.

Figure 8 shows use of gas turbine exhaust as combustion air in lime kilns. This usage may be applicable to larger

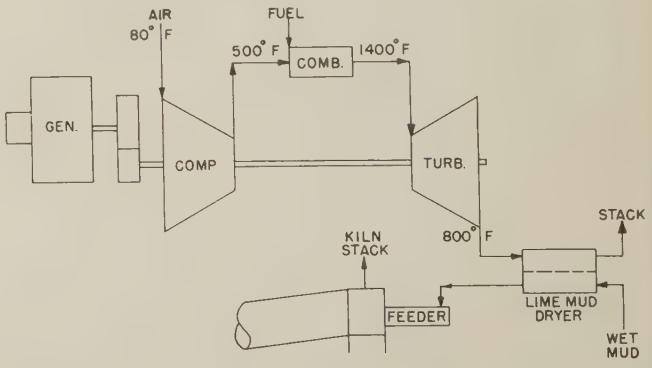

Fig. 10. Gas turbine—exhaust to dry lime mud to kiln

mills which run more than one kiln. It will not increase the capacity of the kilns but will cut down the fuel consumption in them. It may be combined with Fig. 10.

Figure 9 shows gas turbine exhaust, diluted to reduce temperature if the product so demands, used in drying the pulp or board. To the extent of B.t.u.'s supplied this usage will reduce the extraction steam consumed by the driers. This

usage is applicable where the driers are equipped with the enclosed type of hood which has more recently come into use.

Figure 10 shows gas turbine exhaust used to dry lime mud kiln-feed. This usage will not only decrease the amount of kiln fuel per ton of lime burned, but will also materially increase the capacity of a given kiln. This may be very important to any mill where the kiln is up to capacity and constitutes a bottle-neck. It may be combined with Fig. 8 and either or both of these schemes may be feasible if the added gas turbine can be located near the kiln.

It should be obvious that, in many cases, combinations of a number of the above schemes may be both possible, practical, and profitable.

SALIENT FEATURES OF A GAS TURBINE INSTALLATION

First cost of a gas turbine and related combined equipment is less than that of any other combination of previously used equipment which may provide the same combined output.

Gas turbine foundation requirements are simple and inexpensive compared with comparable multiple-extraction condensing steam units.

Space requirements are small; and the cost of the supporting and enclosing structure is low.

Maintenance records on an impressive number of presently operating gas turbines are surprisingly low. One unit which was on the line since July, 1949 showed, at 27,000 hr., total maintenance cost around 1 dollar per kw. of Summer capacity. Machines built since then will show even lower maintenance figures.

Start-up is simple and fast; and a stone-cold unit can be put on line in 10 or 15 min., against the hours required to fire up steam boilers and warm up steam turbines. This fast start-up shows up prominently in the numerous applications in locomotives with 4500 traction hp., which are fired-up and promptly driven away with full load and no fuss.

Control is simple and effective, requiring minimum attention. It is easily amenable to fully automatic operation with remote supervision and control. The standard controls include automatic alarm and shut-down, against loss of fuel, flame, or lube oil pressure. Excessive vibration, exhaust temperature, or bearing temperature sound an alarm but do not shut down the unit unless the trouble remains uncorrected for some predetermined time. One single switch easily controls the entire starting sequence.

Combustion gas turbines may be fired by liquid fuel. There are large units in both Great Britain and Holland which are fired by bunker C with, however, considerable purification. In the United States a number of units are fired with distillate and pre-treated light oils such as no. 2 fuel, diesel and similar oils. Natural gas is, however, the preferred fuel since it eliminates problems of corrosion and erosion in nozzles and blading. The liquid fuel possibility must be here mentioned because it is one of the possible solutions of the pulp and paper mill problem concerning the "interruptible" clauses in most natural gas contracts which involve rates that might appeal to such customers.

There are other ways in which the pulp and paper mills may combat the "interruptible" problem which need not be herein detailed.

We believe that, in any case and particularly where natural gas may be available, or may shortly become available, it will pay handsomely to include in any proper study, a consideration of the combustion gas turbine.

In conclusion we are happy to quote one of the leading gas turbine manufacturers whose literature includes the advice: "However, each case should be carefully studied by competent engineers so that accurate and complete installation and operating costs are established."

Presented at the Fourth District Convention of the A.I.E.E., St. Petersburg, Fla., April 13–15, 1955.

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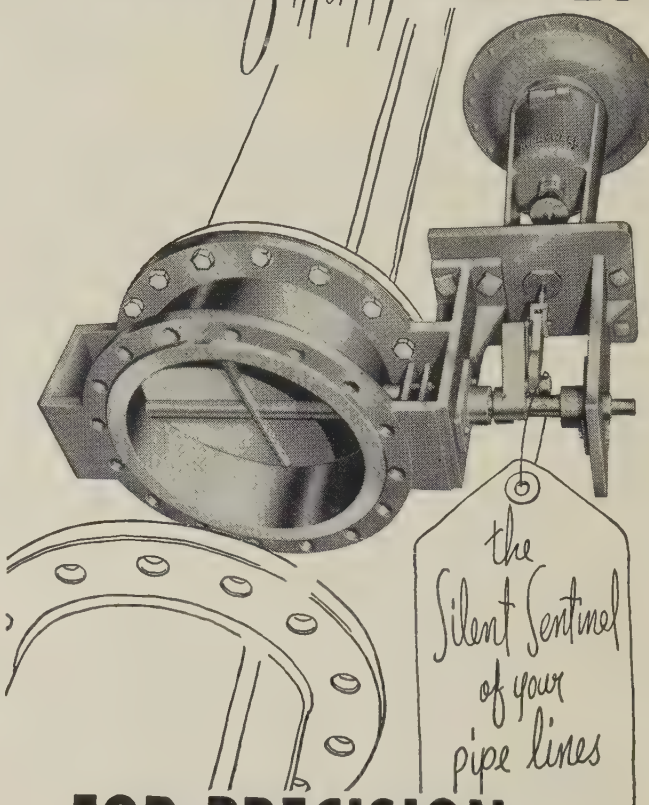

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RC-252. Pulp Pads for Brightness (British Sheet Mold)

Measure out the required volume of slush stock to give approximately 3 grams of fiber. Dilute to 1 liter with distilled water. (Tap water of good quality may be used in place of distilled water but the results obtained should be checked against distilled water occasionally.) Pour the diluted stock into a British sheet mold which has the wire just covered with water.

Drain the mold and couch the sheet from the wire onto a clean blotter. Press the sheet in a sandwich of six dry blotters for 30 sec. at 50 p.s.i. Remove the pressed handsheet from the blotters and dry for $3^1/_2$ min. on a coarse mesh screen heated from above and below by infrared lamps. The drying time should be kept to a minimum and the sheets should not be dried over 90% moisture-free.

Determine the brightness on the handsheets according to standard procedure for the brightness meter used.

Source: J. Wayne Duppen, Marinette Paper Co., Fort Edward, N. Y.

RC-253. Ash in Paper (Oxygen and Electric Furnace)

This method may be used for routine determination of ash in paper. Time required for weighing of sample, burning, cooling, and reweighing is about 5 min. Accuracy is excellent for routine control.

Equipment

A. An electric crucible furnace. The multiple unit, type 80, 115 volt, 890 watts, manufactured by the Hevi-Duty Electric Co. of Milwaukee, Wis., has been found most satisfactory.

B. A commercial cylinder of oxygen fitted with a pressure reduction control valve and a metal adapter tube to fit $^1/_8$-in. i.d. heavy duty tubing. Attached to the other end of the tubing is an oxygen injection nozzle made of $^1/_4$-in. copper tubing, coiled midway to dissipate heat. The nozzle tip is a $^1/_8$-in. case iron street El attached to the copper tubing. An adjustable friction disk attached to the nozzle assembly in the region of the coil and held in position by a ring stand permits the nozzle to be tilted to any position at will.

C. Cooling Grill: For cooling purposes, a satisfactory unit is a blower unit, model 3746, Type L, 115 v. manufactured by the Redmond Co., Inc., Owosso, Mich. It is surface mounted and piped over to a small 6 by 6-in. grill.

D. Nickel Crucibles: Nickel crucibles, though not perfect, seem to be the best available for the purpose. Porcelain crucibles have not been satisfactory. To minimize the effect of tare weight, a sizable paper sample should be taken, in the range of 3 to 4 grams. A polished crucible of about 65 to 70 ml. capacity has been found satisfactory.

Procedure

Weigh in a tared nickel crucible 3 to 4 grams of air-dry paper. Place the crucible with paper in the preheated crucible furnace. Tilt the oxygen nozzle down to the plane of the top of the crucible. As soon as the paper ignites, turn on very slowly a small amount of oxygen. This should be done with extreme care since there is danger of blowing the ash from the crucible. Experience will dictate the right amount of oxygen which should be just enough to support an intense white glow. Combustion will be complete when the white glow disappears and usually takes about 1 min. Remove the crucible with its ash to the cooling grill and weigh when cool. Calculations for percentage of ash are done in the usual manner.

Source: D. F. Petersen, Bergstrom Paper Co., Neenah, Wis.

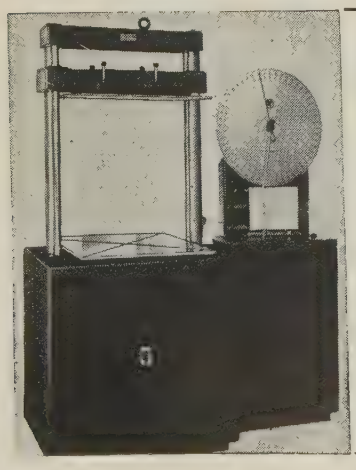
RC-254. Alkali Resistance of Paper (Caustic Staining)

Prepare standard solutions of sodium hydroxide at concentration of 1.00, 0.50, 0.25, and 0.10%. Keep these solutions in rubber-stoppered glass dropping bottles.

Place 2 drops of the solution of each particular strength on each of four spots across the sheet, making sure the drops are far enough apart not to run together. Make a row of drops with each strength caustic solution and label each row as to the strength.

Allow the caustic to dry on the sheet. A yellow spot indicates staining. The darker the yellow discoloration, the more the paper is susceptible to staining with alkali.

The sheet generally should show no staining using 0.25% caustic solution.



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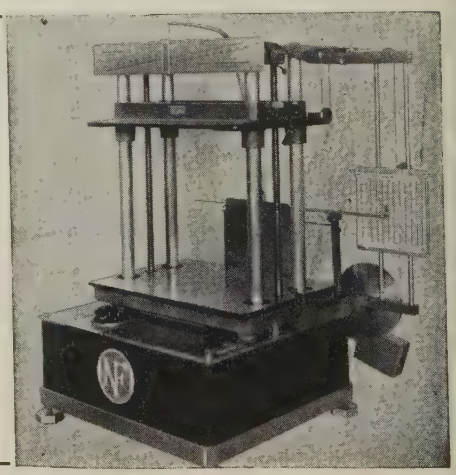

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Empire State

The annual meeting of the five districts of Empire State Section was held at Whiteface Inn at Lake Placid, N. Y., June 9–11, 1955. Total registration for the event was 252.

At the business meeting on June 9 the officers for the 1955–56 season were announced:

Chairman, W. R. Willets, Titanium Pigment Corp.
First Vice-Chairman, Gordon K. Storin, Niagara Alkali Co.
Second Vice-Chairman, Grant G. Cole, Finch, Pruyn and Co.
Third Vice-Chairman, J. Wayne Morrow, Newton Falls Paper Mill
Secretary-Treasurer, Ralph N. Prince, Fort Orange Paper Co.

The Executive Committee at this meeting confirmed the dates of June 7–9 for the annual meeting at Whiteface Inn for 1956.

The program for Friday morning, under the chairmanship of F. W. O'Neil included the following papers:

1. "The Seaway—Its Economic Significance," by George O. Von Frank, Associate Economist, New York State Department of Commerce.
2. "Availability of Woods in New York," by James Davis, Professor of Forestry, State University of New York, College of Forestry.
3. "Semichemical Pulping of Hardwoods with Sodium Bisulphite," by Robert M. Husband, Research Associate and Project Leader, Pulp and Paper Technology, State University of New York College of Forestry.

In the afternoon under the chairmanship of W. R. Willets the following three papers were presented in competition for the "Empire State TAPPI Award":

1. "Kraft Pulping of Various Species of Hardwoods from Northern and Southern United States," by Maung Mai Aung, St. Regis Paper Co.
2. "Centri-Cleaning of Sulphite Pulp," by Donald Anderson, International Paper Co.
3. "Experiences with Molded Fiber Sizing," by N. F. Rauscher, Diamond Match Co.

The high caliber of all three papers was such that it was very difficult to decide on a winner. The three judges (i.e., Horace Spencer, Tony Wirpsa, and Homer Rice) decided to split first prize between Maung Mai Aung and Donald Anderson. N. F. Rauscher was awarded the second prize.

Following the "Junior Award Contest" the Titanium Pigment Corp.'s film entitled "The Ninth Element" was shown. This film set forth a very interesting review of the mining of titanium ore and the manufacture of titanium pigments.

George Booth of the Black-Clawson Co. was chairman of the Saturday morning technical session. The papers presented were as follows:

1. "Machine Coating of Paper Board—The Coating Equation," H. C. Fisher, Consultant to the Technical Department, Gardner Board & Carton Co., Lockland, Ohio.
2. "Printing of Board or Paper by the Lithographic Process," Ray Shalvoy, Technical Director, Stecher-Traung, Rochester, N. Y.
3. "Coating, Laminating and Pasting for Converted Paper Products," by W. E. Anderson, Technical Superintendent, Converting Department, Riegel Paper Corp., Milford, N. J.

The social program started with a "get acquainted" party Thursday evening. The number of participants at the costume dance on Friday night was much greater than in previous years. The ladies enjoyed canasta, golf, and the boat ride on Lake Placid. Competition was very keen in both the trap shooting and golf for the men.

The committee members for this meeting included:

Chairman—F. G. Sommerville, Armstrong Cork Co., Fulton, N. Y.
Technical Meetings—F. W. O'Neil, College of Forestry, Syracuse, N. Y.; G. L. Booth, Black Clawson Co., Fulton, N. Y.
Junior Award Papers—W. R. Willets, Titanium Pigment Corp., New York, N. Y.
Reservations and Finance—Gus R. Holm, Derrico-Canastota Co., New York, N. Y.; R. N. Prince, Fort Orange Paper Co., Castleton, N. Y.
Reception and Registration—W. R. Willets, Titanium Pigment Corp., New York, N. Y.
Publicity—G. K. Storin, Niagara Alkali Co., Niagara Falls, N. Y.; R. S. La Rue, Socony Vacuum Oil Co., Albany, N. Y.
Social Events—Mr. and Mrs. J. J. Lynch, Corn Products Refining Co., Utica, N. Y.; Mr. and Mrs. Roy P. Sullivan, Monsanto Chemical Co., DeWitt, N. Y.
Golf—D. W. Geffkin, Oswego Falls Paper Co., Fulton, N. Y.
Trap Shooting—E. N. Zoller, Titanium Pigment Corp., New York, N. Y.
Ladies' Events—Mrs. F. G. Sommerville; Mrs. R. N. Prince and Mrs. Gus R. Holm
Toastmaster—Homer E. Rice, E. I. du Pont de Nemours & Co., Inc.

The Seaway—Its Economic Significance

George O. Von Frank

THE power and seaway projects now under way on the St. Lawrence River represent direct expenditures by the

GEORGE O. VON FRANK, Associate Economist, Bureau of Business Research, State of New York, Department of Commerce, Syracuse, N. Y.

Committee members for the annual meeting of the Empire State Section, front: Mrs. Sommerville; R. N. Prince, Fort Orange Paper Co.; W. R. Willets, Titanium Pigment Corp.; F. G. Sommerville, Armstrong Cork Co.; G. K. Storin, Niagara Alkali Co.; and Mrs. Prince. Rear: Mrs. Holm; G. R. Holm, Derrico-Canastota Co.; Mrs. Sullivan; R. P. Sullivan, Monsanto Chemical Co.; F. W. O'Neil, College of Forestry; G. L. Booth, The Black-Clawson Co.; D. W. Geffkin, Oswego Falls Paper Co.; J. J. Lynch, Corn Products Sales Co.; and Mrs. Lynch

United States and Canada of approximately $1 billion. These projects are expected to generate close to another $1 billion in related Federal, State, community, and private spending. The St. Lawrence power and seaway projects will bring many benefits to the economy of the United States, and New York State is expected to share importantly in these benefits.

On the one hand, the additional power generated will satisfy the expanding power needs of New York and other areas. On the other hand, the deeper seaway will lower the cost of transportation, and thereby increase the movement of goods between areas. This will, in turn, stimulate industrial development in the areas reached by this new means of transportation. That is what happened when past new transport systems were built, such as the pioneer overland turnpikes, the Erie Canal, and cross-country railroads and highways.

Before detailing the economic effects, I will briefly describe the two projects. Although the power and seaway jobs dovetail, each is being financed, constructed, and will be operated by separate governmental agencies. Many agencies are involved; however, the principal ones for the United States are these: for the seaway—the St. Lawrence Seaway Development Corp., a Federal organization under the Secretary of Defense and employing extensively the engineering services of the United States Army Corps of Engineers; and for the power project—the New York State Power Authority, under license from the Federal Power Commission.

To describe the seaway first—the seaway project is essentially a deepening and a widening of the St. Lawrence River to a 27-ft. depth, thereby creating a deep channel from Toledo, Ohio, to Montreal. Although a waterway over this stretch has existed on the Canadian side since early in the century—in fact, from Duluth to Montreal—the shallow, 14-ft. depth in some sections has severely limited the size of ships, and hence the amount of traffic, that could be economically carried.

The principal United States work on the seaway will be in the 46-mile International Rapids section, between Ogdensburg on the west and Massena on the east. The United States will build the Long Sault Canal near Massena; this will be 8 miles long, have two locks, and there will be a tunnel to carry traffic under the canal. There will also be considerable dredging throughout the Rapids and some work in the Thousand Islands area. Canada will build the 17-mile Lachine Canal near Montreal and this will have four locks. Canada will also build the 3 mile Point Rockway Canal near Ogdensburg and will deepen the 25-ft. Welland Canal around Niagara Falls to 27 ft.

The locks throughout the system will be much larger than existing locks. They will be 80 ft. wide, as against 44 ft. wide in the present system, and 800 ft. long, as against the 252-ft. length of those in the present system. Much larger ships, therefore, will be able to ply the new waterway. Today, the maximum cargo is about 3000 tons per vessel. The new channel will take ships holding 7000 tons—in some instances much more. Greater cargos mean lower transportation costs per unit of freight carried. While no huge passenger liners will be seen, most of the world's freighters, and many American ones, will be able to use the seaway.

The total cost of the seaway, from Montreal to Toledo, will be about $300 million, of which the United States will spend approximately $100 million and Canada $200 million. The United States portion will be financed by the sale of Seaway Development Corp. bonds to the United States Treasury, with repayment to be made out of tolls within a 50-year period. The possibility of extending the deep waterway further west to Duluth is at present under study by the United States Army Corps of Engineers and Congress. The cost of such an extension is estimated as at least $100 million more.

While potential benefits of the seaway are large, they will not fall into the laps of communities along the route of the seaway simply upon construction of the deeper channel. Today, not a single port on the Great Lakes or the St. Lawrence River can take the larger ships expected on the new waterway. Before such ports will be able to handle these ships, a great deal of local harbor work will have to be done: (1) harbors along the seaway must be deepened to take the bigger ships that will appear; (2) piers and wharves must be built to handle the additional cargos anticipated; and (3) auxiliary on-shore facilities of all sorts will have to be provided.

The deepening of main harbor waters is a Federal responsibility—only Congress and the President can authorize it. The competition for Federal funds is exceedingly keen; Chicago, Cleveland, Toledo, Duluth, Milwaukee, Gary, and other ports are laying extensive plans. In deciding what harbors are to be deepened and to what extent, Congress will be guided in part by community actions and attitudes. In order to get Congress to approve and then to appropriate money for a project, a community has to marshall all the facts it can on its cargo-generating capacity and organize local business and civic groups in behalf of the proposal. As a matter of fact, there are 23 steps between a community's initial decision to seek a deeper harbor and the actual start of construction, according to the United States Corps of Engineers.

Federal work, however, is confined to entrance channels, breakwater protection and the dredging of main ship channels only. The community must arrange for dredging berthing areas and for building piers, wharves, warehouses, cargo-handling facilities, and rail and highway facilities. At present, Federally authorized harbor projects in New York State amount to about $31 million, including projects at Buffalo, Tonawanda, Oswego, and Ogdensburg. However, only a small part of these authorizations is covered by actual Congressional appropriations.

Even if these plans materialize, none of the harbors will equal the 27-ft. depth of the seaway. Buffalo, for example, would only be 22 ft. deep, while Tonawanda, Oswego, and Ogdensburg harbors would only be 21 ft. deep, and other ports would be of even lesser depth. Ports in New York State have programs under way to remedy this situation. Buffalo has outlined plans for it to spend $23 million in port improvements; it has made surveys of traffic and industrial possibilities; and it is setting up a State-chartered Port Authority. Oswego has also been very active in organizing local interests and in planning expansions, including provision for a full-time municipal port director. Oswego is also getting a Port Authority under act of the State Legislature. Other places examining their port potential include Rochester, Dunkirk, Ogdensburg, and Watertown. All these local projects could run to $100 million in spending in addition to expenditures on the seaway proper.

Turning to features of the St. Lawrence power project, the generation of power is made possible by the great drop in water level in the relatively short International Rapids section of the St. Lawrence River between Ogdensburg and Massena. Near Massena, at the downstream end of the Rapids, the Barnhart Island powerhouse will be built. This will be a massive structure, a combination powerhouse–dam, that will generate 13 billion kw.-hr. of electrical energy per year, making it second in size only to Washington State's Grand Coulee Dam. The United States and Canada will share equally in the power, with the United States half thus being 6.5 billion kw.-hr. per year. The capacity of the American half of the plant will constitute, it is estimated, one-fifth of the total power capacity in the marketing area to be served.

Besides the Massena powerhouse–dam, the power system will require two other dams—the Long Sault Dam, a short distance upstream from the powerhouse–dam, and the Iroquois Dam, 27 miles up the river toward Ogdensburg. Both of these are control dams.

The aggregate cost of the power system will be somewhat over $600 million, to be divided evenly between the United States and Canada. The United States share will be financed by 30-year bonds; the New York State Power Authority has already publicly sold $335 million in such bonds.

A noteworthy feature of the St. Lawrence power system is the constant flow of water, thus insuring a much greater uniformity in energy generation than is possible with many other hydroelectric sources in the United States. The prospect of atomic power will not threaten the utility of the St. Lawrence project, according to the State Power Authority. Ten years

Officers of the Empire State Section: G. G. Cole, Finch, Pruyn Co., G. K. Storin, Niagara Alkali Co.; F. G. Sommerville, Armstrong Cork Co.; W. R. Willets, Titanium Pigment Corp.; and R. N. Prince, Fort Orange Paper Co.

from now, the Authority estimates, a nuclear power plant will still be relatively inefficient and able to compete with only one-tenth of the *new steam* plants built that year—those steam plants with the highest operating costs.

I turn now to the effects of the seaway and power projects and, first, the effects during construction.

The construction job will take about 5 years, with completion set for 1959. At the peak of activity, about 1956 to 1957, perhaps from 7000 to 9000 American workers will be required on the combined enterprise. The main force of workers will be drawn from local sources, but that force will be supplemented by specialized personnel, about 3000 to 4000, from places outside the immediate construction area. Many of these workers will bring their families along. It has been estimated that the new workers plus their families will swell the population in the construction area by about 10,000 persons.

Besides stimulating employment, the seaway and power projects will call on industry in this State and elsewhere to supply large quantities of construction materials. The dams and powerhouses, for example, will require 78,000 tons of structural and reinforcing steel, and 3 million cu. yd. of concrete. The seaway locks, gates, and other structures will take 11,000 tons of steel products and over 1 million cu. yd. of concrete. These direct effects on employment and on industrial purchases will be accompanied by important secondary developments in the northern area. Several thousand additional houses will be necessary for families of workers. Retailing will expand, as will wholesaling, banking, repair services like garages, and personal services like barber shops, as well as other branches of trade and industry. Already new stores, motels, new telephone facilities, warehouses, and other business expansions are well under way. The expansions in population and in business are also bringing with them needs for many public facilities which local communities must supply—schools, water systems, sewer systems, fire-protection facilities, and additional hospital space.

While much of the increased activity will fade away when the construction job is completed—the operation of the seaway and power projects requiring a relatively small force—there will be three important lasting effects on New York State from these two major developments. The three principal consequences anticipated are: (1) a rise in industrialization, and therefore in total economic activity, throughout the St. Lawrence-Great Lakes basin; (2) an expansion in foreign trade, both of the United States and of Canada; (3) a growth in the tourist trade of northern New York State.

With regard to the first major benefit—the prospect for industry—the large amount of additional power plus the new means of low-cost water shipment undoubtedly will create a big potential for industrial growth, both in areas immediately adjacent to the seaway route and in regions further away. While greater industrialization can thus be foreseen in general terms, it is impossible at this time to predict specifically what industries will be brought in and where they will be located. We can, however, make a rough estimate of what is likely to happen.

New industry, if it comes, will find it most economic to locate close to the power source or the seaway if it depends primarily on either power or on cheaply shipping in raw materials or on shipping out finished products. However, locations at some distance may be desirable if other factors play an important role in a particular industry. Such factors might be a need for specialized labor skills, a need to be close to the market, an ability to use the Thruway in company operations or a necessity for being near certain raw materials.

The size and nature of industrial expansion in areas close to the seaway will also depend on other major factors: (1) the extent of Federal appropriations for harbor work along the seaway; (2) the efforts which local governmental and community groups put forth to promote the building of piers, warehouses, and other essential port facilities; and (3) the amount of power that will be available for sale to industry in New York State and the amounts that will be allocated for nonindustrial purposes and for other areas.

Exactly how the St. Lawrence power will be distributed will be decided by the State Power Authority, with the approval of the Governor, and currently the Power Authority is negotiating contracts with prospective users. According to the 50-year license from the Federal Power Commission under which the State Power Authority operates, a reasonable portion must be reserved for nearby states. Thus, far a contract with Vermont is pending, and other states are studying the matter. It is anticipated that another block of power will be set aside for residential and rural consumers, in accordance with State law. The needs of municipalities and cooperatives will also be considered. For example, the Power Authority is expected to supply some power to the city of Plattsburg.

Since it is recognized that industrial use of the power is also necessary for the economic development of the area and in order to utilize off-peak energy and permit low rates to other users, a substantial amount of St. Lawrence power will probably be available for commercial and industrial use. The Power Authority has arranged to sell the Aluminum Co. of America the power from 174,000 kw. of firm capacity and from 69,000 kw. of secondary capacity, and the Governor has approved the agreement. The Authority expects to sell considerable additional power to other firms in the North Country or to industry moving into the area.

If new manufacturing enterprises are attracted to the State, what kinds are they apt to be? They will probably be industries depending greatly on power for use in their production processes and industries which can utilize low-cost water transportation for importing bulky raw materials or for shipping out finished products. Industries of the first sort—power-oriented industries—would be drawn principally to the Northern Area, close to the power source. Industries of the second type—transport-oriented industries—might locate there or favor more westerly sites, such as the Oswego, Rochester, or Buffalo sectors, or others more convenient to sizable consumer markets.

Among the industries qualifying under the conditions mentioned would be electrochemicals, electrometallurgicals, metal fabricating, fertilizers, abrasives and, perhaps, coffee roasting or sugar refining. Once a basic manufacturing industry is attracted, other industries may be expected to follow—retailers, wholesalers, financial and service businesses, etc.

The second major effect on the State's economy of developments along the St. Lawrence, based primarily on the completion of the 27-ft. water passage from Lake Erie to Montreal and beyond to the Atlantic Ocean, is expected to be a stimulation of the overseas trade of both the United States and Canada. As a result, New York's economy should benefit, inasmuch as New York participates in a great deal of this trade. In addition, producers not now shipping abroad, but who are near the State's ports on the Great Lakes or St. Lawrence River, are expected to train their sights on the new opportunities the seaway offers for competing in European and other foreign markets.

A key aspect of the anticipated growth of foreign trade is the effect of the seaway on Canada. In the past decade Canada has been growing rapidly as the land's vast mineral, forest, and other natural resources have developed. This growth has resulted in Canada's supplying this country with increasing quantities of raw materials and has made her a greater buyer of United States products. As the seaway helps Canada trade more widely and grow still more, New York State cannot help but gain. The most heavily populated and industrialized provinces of Canada lie to the north and west of New York State, and, last year, the Buffalo, Rochester, and St. Lawrence customs districts handled nearly $1.5 billion in trade between the United States and Canada and other countries.

Estimates of commerce that will travel the seaway vary widely. The Seaway Development Corp. has optimistically estimated that about 36 million tons of cargo would move up and down the new waterway during the first full year of operation—this would be a tripling of the approximately 11 million tons on the existing shallow channel. It also foresees a gradual increase to 52 million tons annually 5 years later—this would be one-fourth more than the annual traffic on the Panama Canal.

Even with the present 14-ft. channel, the trade of the United States with Europe and North Africa over the seaway route has risen considerably within recent years. Fifteen shipping lines now provide such service, with the number of their freighters plying the route almost doubling in the last three years. This year, about 100 such freighters are expected to make the journey, averaging three trips each during the season.

The prospect for growth in foreign trade of the Great Lakes ports as a whole is suggested by looking at past long-run trends. Exports by water from all Great Lakes ports in the United States have increased at a much faster rate than other United States waterborne trade in the past 25 years, Great Lakes export tonnages more than doubling between 1927 and 1952. Gains in such exports should continue as domestic manufacturers turn more and more to foreign markets in their recognition of the opportunities offered by the seaway. While imports at Great Lakes points of entry have been less in recent years than several decades ago, a reversal of this trend can be expected upon completion of the seaway, as American firms utilize the new channel for shipping in expanded purchases of foreign raw materials.

For example, ore imports will expand greatly. Imports of iron ore, in particular, will probably make up the largest single item of traffic on the deeper seaway. These iron ores will come up the river from the rich new Labrador–Quebec fields and other foreign sources to make up a vital supply for this country's steel plants, now facing depletion of ores from the Midwest's Mesabi Range. The seaway thus assures the steel industry of getting iron ores from abroad at low water-transport rates similar to those previously enjoyed on domestic ores. Initial shipments of Labrador-Quebec iron ores began last year, 70,000 tons going to Buffalo via the existing channel. Other ores are expected to travel up the seaway too—copper, lead, chromium, and others.

Shipments moving up the seaway will also include petroleum products and a variety of other raw materials. A recent survey in the Buffalo area indicated that firms there foresaw seaway imports of cocoa beans, spices, jute, shellac, crude gums, natural rubber, cork, waxes, burlap, quebracho, and many other items. Products moving from Canada to the United States in increasing amounts will include newsprint, pulpwood, wood pulp, and lumber. Flour and grain are expected to move down the river to the Atlantic in large quantities and coal will move from this country to Canada's industrial users.

F. W. O'Neil, College of Forestry, State University of New York, program chairman; W. R. Willets, Titanium Pigment Corp., junior award chairman; G. L. Booth, The Black-Clawson Co., program chairman; and G. K. Storin, Niagara Alkali Co., publicity chairman

If expectations of ports along the seaway are realized, various finished products will head for Europe and elsewhere via the seaway—such industrial machinery as dairy, bakery, metalworking and cloth-cutting equipment, as well as agricultural machinery, automobile parts and accessories, iron and steel products, office appliances, industrial chemicals, medical equipment, toiletries, industrial meters and other controls, and railway equipment.

The third major effect on the State's economy to be expected from the seaway and power developments is the expansion of the tourist trade of northern New York State. Similar large-scale projects, such as TVA, Hoover Dam, the Welland Canal, etc., have regularly drawn vacationers and travelers. Thus, many tourists are likely to put on their itineraries the great powerhouse, dams, and locks of the St. Lawrence system.

A valuable by-product of the power facility will be the huge new lake that will be formed by the damming of the river above the powerhouse at Massena. This lake will be about 30 miles long and several miles wide. The transformation of formerly turbulent rapids into broad placid waters will create opportunities for fishing, boating, swimming, and for the enjoyment of the scenic beauties of the region.

Several recreational areas are contemplated by the State Power Authority. There will be one of about 1000 acres on Barnhart Island, site of the Massena powerhouse, which will have parking facilities, overlooks, playfields, picnic areas, and paths. Another area of about 1700 acres will be opposite the island on the American shore, and will be called St. Law-

rence State Park. This will offer a panoramic view, from a promontory 40 ft. above the lake, of the river valley, the canals, and the dams. Upstream, near Waddington, the State highway will become a scenic riverfront boulevard. Sites for waterfront cottages on land midway between Waddington and Massena will be provided.

Such an expansion of recreational attractions should bring a sizable influx of visitors and more business for the North Country's tourist homes, motels, gas stations, and stores. Areas some distance from the seaway and power sites are also getting a lift. Thousand Islands resorts, for instance, have refurbished and increased their famous facilities for handling visitors. The Watertown region has added many motel units, as have other communities which can serve as convenient stopping places for seaway sightseers.

To sum up the economic significance of the two developments on the St. Lawrence, the initial construction of dams, canals, and powerhouses will generate $1 billion in spending for labor, materials, and equipment over a 5-year period, stimulating activity primarily in the Northern area but also contractors, suppliers, and workers in other areas. These direct expenditures, will lead to close to another $1 billion for many other related facilities—housing, schools, and other local public works, retail and other business enterprises, new industrial plants, harbor deepenings and additional piers, wharves, warehouses, and cargo-handling terminals. Beyond that, there is further potential for the development of other lines of business and hence for a general economic expansion throughout the interior regions of northern and central United States.

Some Observations on the Forest Resource of the Adirondack and Catskill Regions

J. E. Davis

When I received a memorandum on April 20 from your program chairman concerning a paper for this meeting under the title "Hardwoods of the Northeast," I felt he was spreading my knowledge and experience over some territory to which I have little claim of familiarity. Then, along came the May issue of the *Northeastern Logger* which took me off the hook, at least temporarily. The article in this magazine, on "The Northeast Timber Reservoir," by Ralph W. Marquis, Director of the Northeastern Forest Experiment Station, took care of my first assignment very nicely. If you have not read the article, I recommend that you do so.

Then, Professor O'Neil put me back on the hook with the topic, "Availability of Woods in New York." This is getting closer to home, but I am going to take some liberties, even with this topic. I shall give this paper only a general title and will attempt to give you a variety of information, particularly concerning the hardwood resource, which I hope will be enlightening and which can be documented safely within the area of my own experience.

Although the U. S. Forest Service data for the New York forest survey have been published by forest districts, the overall summary for the state has not yet been released. However, the College of Forestry made a more intensive forest inventory of the Adirondack and Catskill regions in the period of 1950 through 1952, the results of which have been published in the College of Forestry Bulletin 35, "Forest Acreage and Timber Volume in the Adirondack and Catskill Regions." From this I shall draw data, specific for these regions and indicative of the situation throughout the state.

The Adirondack-Catskill forest survey covered 81 towns in 14 counties in the Adirondack and Catskill regions. In the Adirondack region 5,201,000 acres were surveyed—831,000 acres less than the area of the Adirondack Park. In the Catskill region, however, the survey area of 979,000 acres exceeded the Catskill Park area by 398,000 acres. Coverage was 100% within the survey areas, including all land in both private and public ownership. Together, the survey areas included a little over 6 million acres of land, or approximately one-fifth of the state; and covered 5.5 million acres of forest which is more than one-third of the total forest area of the state. Hereafter, when reference is made to the Adirondack area or Catskill area, please keep in mind that I refer only to the specific acreages covered by this forest survey.

When it comes to consideration of the forest resource, desirable facts to know are the amount and condition, where it comes from, how it is being used, and how well it is being replenished. I will assume that as pulp and paper men you are interested more in cubic foot volume than board foot volume, and particularly in the cubic foot resource of hardwoods.

The total volume of merchantable timber in the Adirondack area amounts to about 16 billion board ft., or $5^1/_2$ billion cu. ft. which would be about $62^1/_2$ million cords. The Catskill area has 750 million board ft., or 500 million cu. ft.—about $5^1/_2$ million cords. Combined, the total merchantable volume on this third of the forest area of the state amounts to approximately $67^3/_4$ million cords.

The existence of a forest resource and its availability are two quite different matters. The amount of privately owned timber volume which is not available for commercial use for various reasons is, for the present, an unknown quantity, but it is certain that nearly one-half of the total merchantable timber volume in the Adirondacks and Catskills is not available to industry because it is on State Forest Preserve lands. This would not be true of other regions of the state, but in the Adirondack and Catskill regions it cuts the commercial timber resource down to about $34^3/_4$ million cords.

Over 10 million cords out of the nearly 35 million are made up of conifers, over half of which are pine and hemlock. The other 24 million cords are hardwoods, among which hard maple and birch dominate, with important amounts of beech, soft maple, and elm.

Board foot-wise, the quality picture for Adirondack and Catskill timber is not too good. Considering gross board foot timber volume, rather than merchantable volume, roughly only one-third is of good enough quality to assure commercial usefulness as logs; a third is of mediocre to poor quality which seldom can be marketed in the Adirondacks but usually is utilized in the Catskills; and a third is so poor that it has practically no commercial value. Since much of the rejection of timber volume for sawlogs is due to factors other than decay which are not so objectionable in cordwood, and since cordwood diameter limits are lower, the quality situation for cubic foot volume is much better.

On whose land is the Adirondack and Catskill timber resource standing? New York State owns 36% of the survey area; a greater acreage than any other individual owner. The State owns 56% of the gross board foot timber volume, and as has already been pointed out, nearly one half of the net volume.

The second largest ownership is made up of farm and small nonfarm holdings, totaling about another 36% of the survey acreage. These small holdings are of major importance to the economy of the areas since they are the source of substantial quantities of forest products for industrial use. These owners hold about one third of the net cubic foot timber volume outside the State Forest Preserve.

Wood-using concerns own 16% of the survey area, located mostly in the six northern counties of the Adirondack region. There is little industrial ownership in the Catskill region. Large estates, clubs, and associations own extensive acreages in both regions, amounting to 8% of the total survey area.

Unfortunately, the analysis of the data on use of wood from the Adirondack and Catskill forest resource is not quite complete and I regret that I cannot give you complete informa-

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tion on the amount and character of forest drain from these areas. The College of Forestry recently completed field work on a survey of wood use throughout the entire state, the results of which are being prepared for publication.

We can get some indication of what is happening by looking at the situation here in Essex County, for which I have picked out data from the state-wide survey.

The total board foot timber volume cut in Essex County and used by wood-using industries and on farms in 1952 was 72,307,000 board ft. Timber volume growth in that year, outside the State Forest Preserve, was 43,216,000 board ft., so that the cut exceeded growth by 29,091,000 board ft., or 67%. The total net board foot volume inventory was reduced by 1.8%. For most tree species use in board feet exceeded growth. White pine and red pine were used heavily, the cut exceeding growth by 111%. For spruce and fir use exceeded growth by 48%.

In terms of cubic foot timber volume, most tree species groups grew more wood than was used. The total cubic foot volume cut in Essex County in 1952 was 13,462,800 cu. ft. (equivalent to about 150,000 cords). The forests of the county, exclusive of the State Forest Preserve, grew 16,034,000 cu. ft., so that growth exceeded use by 19%, and the total cubic foot timber volume inventory change was an increase of 0.4%. Even in cubic foot volume, white pine and red pine use was 26% more than growth, but spruce and fir had the narrow margin of 6% in favor of growth. All of the hardwoods produced more cubic foot volume by growth in 1952 than was used.

Relatively speaking, merchantable timber volume growth in the Adirondacks is poor, amounting to only 2% annually in cubic feet. Cubic foot growth in the Catskills is 3.6%. Excluding the State Forest Preserve, the Adirondack and Catskill regions are producing about 900,000 cords of wood annually by growth. It is felt that good forest management could at least double growth in these areas, so that this third of the State's forest area has a potential of producing 1.8 million cords of wood annually, about two-thirds of which would be hardwoods. Current growth is known to be better throughout the remainder of the state than in either mountain region.

The aspects of the current supply of good quality sawtimber volume in the Adirondack and Catskill areas, and the outlook for adequate supplies in the near future are discouraging. Economic factors and trade customs limit the species and quality of trees that can be utilized commercially for sawlogs. Within these limits the overcut is severe, and there is no evidence within the sawlog market from which any marked improvement can be forecast.

The picture for cubic foot volume, on the other hand, is brighter. Expecially for hardwoods, it is one of abundant supply, growth in excess of drain, and a slowly developing market for cordwood that in itself can become a tool for the development of better forest stands and increased annual volume growth. I cannot pass this point without a word of warning. Although markets for hardwood pulpwood may provide the long wanted opportunity to put hardwood silviculture on its feet in the Northeast, at the same time, they can be a threat to the most beneficial use of the hardwood resource. I have already noticed a tendency among forest owners and operators to harvest for pulpwood only the straightest and cleanest trees of sizes most easily handled.

Commercial forest owners have an obligation to the forest owning public and to their communities to point the way toward stability in the wood-using industry through the use of pulpwood harvests for timber stand improvement wherever the practice is indicated and feasible. There is sufficient volume of hardwood to both supply the requirements of the pulp and paper industry and rebuild volumes of good quality timber for sawlog industries.

The place of forest plantations in the forest resource should not be overlooked. There were 31,000 acres of plantations identifiable on the serial photographs of the survey area with red pine the predominant species. These plantations are capable of producing close to 750,000 cords of pulpwood from thinnings. At maturity, they should provide about 1.5 billion board ft. of sawtimber.

Many of the plantations have already reached, or have passed, the point where thinnings are needed, so that there is immediately available considerable of plantation pulpwood and some small sawtimber. For instance, I am familiar with one area of red pine plantations here in northern New York which is badly in need of thinning and from which at least 80,000 cords of pulpwood could be harvested at this time.

The Coating Equation for the Machine Coating of Paperboard

H. C. Fisher

THE thesis of my discussion is that the coating of paperboard with adhesive-mineral mixture in water is a distinctly different thing than the coating of paper, despite superficial resemblances. Certainly with both paper and board a dispersion of finely divided mineral matter in a water solution of adhesive is spread uniformly over the surface of the web, is dried, and is calendered to a desired finish; certainly, with both paper and board the final product is a web of paper having on its surface a dried thin, more or less uniform layer of mineral matter dispersed and "fixed" in an adhesive and calendered to a desired finish. But here the resemblance stops, both in the conceptions underlying the manufacturing processes and in the final coated products, particularly when the paperboard is coated on the board machine.

My thesis proposes, further, that the process of the coating of paperboard can be related to the finished coated board product by the coating equation, a nonmathematical equation of condition,* later to be presented for your scrutiny.

It seems to me that the ideal paperboard, coated or not coated, would have the lowest possible density consistent with the retention in the board's structure of adequate stiffness, strength, "texture," and other necessary physical properties. Also, the ideal coating process would apply coating mixture to the board in the simplest possible manner and yet produce a completely uniform, flat, even layer of coating having minimum thickness, maximum opacity, and brightness and gloss as desired. Moreover, the ideal well-finished coated surface would be produced without resort to a severe calendering process.

However, with due regard to practicalities, it is unreasonable to expect a mineral-coated surface of board to assume *per se* a completely satisfactory finish like a smooth flowing paint or varnish, brushed on. Therefore, the need exists for a moderate and minimum amount of finish calendering even in the approach to the ideal coating process, not only to finish the coated surface but to finish the board itself, including its back liner surface.

The combination of an ideal paperboard, not coated, with an ideal layer of coating, should produce the ideal coated board. To the extent that both board and coating, or one of them, depart from the ideal as in the dimensions of flatness, levelness, uniformity of thickness, and surface finish, that departure must be compensated for by a practical means in order to produce a coated board that approaches the ideal. That means is calendering and procedures auxiliary to calendering (calender box treatment) used to increase its beneficial effects.

Included in the ideal coated board are the specified printing, gluing, and folding characteristics of the coated surface, largely controlled by the nature of the coating mixture used and the fibrous furnish of the paperboard, etc. These char-

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* Webster defines "Equation of conditions" as . . . one made up of quantities of which the relation is shown by the entire equation".

acteristics are very important in coated board for folding cartons.

It is incorrect to intimate that *unrestrained* calendering can be used to finish the coated surface on paper. Certainly the necessity for maintaining cleanliness, smoothness, gloss or flatness, freedom from blackening and show-through, etc.,

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of coated surface on paper requires the careful selection and control of the calendering operation used to finish the coated sheet. Yet, is it not true that paper being so thin in comparison with board, and being made of one and not of several paper layers, and that single layer of paper being made of a single furnish of controlled development, can be calendered with nip pressures significantly higher than are usable with multilayered paperboard, and with less derogatory effect on the coated web? What are the effects of heavy and severe calendering on paperboard?

We know that heavy and severe calendering markedly reduces the thickness of paperboard, increases its density, disfigures the surface of the board by causing the show-through of shives and nonfibrous impurities, discolors the surface, etc. Therefore, if the finish of coated surface on board is to be obtained largely by calendering the price will include the effects just related and means adopted to eliminate those effects—such as, for example, the use of fibrous stock of extraordinary cleanliness.

It is the broad consideration of the means employed for coating and finishing the coated surface of paperboard, and the properties of the coated product that interests us. In that connection it is necessary to define paperboard.

Paperboard is arbitrarily defined in the trade as paper having thickness 0.012 in. or higher. There are exceptions to this, as for example, corrugating board of 0.009 in. thickness, and cardboard—a nontechnical term applied to certain stiff papers 0.006 in. thick or more. We are not concerned with these or other exceptions. The paperboard of this discussion is a thick sheet, usually made on the multicylinder board machine, and in its coated form is commonly up to 0.030 in. and higher in thickness; it is the board used for making paper boxes and printed folding cartons. In contrast, coated paper is less than a few thousandths of an inch thick and is made of a single layer of fibrous stock.

At the risk of oversimplification and criticism let us describe the coating of paper, broadly, by saying that the coating mixture is applied, distributed, and dried as a layer on the web and then is brought to the desired surface finish by ordinary calendering, supercalendering, friction calendering, etc. With on-the-paper machine as well as with off-the-machine coating, the usual practice is to reel up the coated web, and after a period of seasoning in the roll, to augment any calendering done on the paper machine by a final calendering operation from the roll, as by supercalendering. I do not imply that this process is simple; I merely state is it capable of a simple description. Here is a sequence of concise steps, each complicated *per se*, that describes the coating of paper—coated paper for particular end uses, and meeting exacting specifications for the body stock, the mineral coating mixture, and the coated paper—the same as for coated board.

Coated board, as used in folding cartons, for example, meets a triple threat of requirements. There are (1) the general requirements for any coated web of paper fibers; (2) requirements and conditions set up by the differing nature of board versus paper; and (3) the end use requirements of the coated board, as in the printed folding carton or container. We will discuss the three classes of requirements, with prominent attention to the second one.

Perhaps the most obvious method of coating a traveling web of paperboard is to apply and distribute the coating mixture by some convenient means, to dry the coated web, and finally to calender or otherwise finish the coated surface—the same as with paper. This is commonly done using finished board from the roll. In another well-known but not widely-used method the traveling web of board moves directly from the board machine and its calenders to the coater(s), to the driers and finally to and through the finishing calender stacks, without being reeled intermediate to these steps; the process is made flexible by using traveling festoons intermediate the steps. Both these methods resemble the classic one for coating and finishing paper but we can be certain that the board furnish, formula of coating mixture, calendering conditions, etc., are critically selected to meet the triple requirements listed above.

In a sense, the off-the-board-machine coating methods appear to permit an approach to the ideal in coated board because each of the steps involved—boardmaking, coating, and finishing—being distinctly separate entities, is susceptible to exacting control. Just how closely the ideal *is* approached I am unable to say, nor is it important to our discussion.

It is in the coating of paperboard on the board machine where the several steps of boardmaking, coating, and moderate calendering follow each other in quick sequence, and where a severe off-the-machine final finish calendering step is *not* used, that success in the operation and product requires close attention to the characteristics of paperboard.

What are the characteristic attributes of paperboard before and after it is coated, that are so important to the coating process and the product? There are several, which will be described and listed by symbol; they include:

- T = *thickness*—the greater thickness of board as contrasted with paper
- C = *compressibility*—the marked reduction in thickness of board when severely calendered, and when calendered damp
- Fd = *fiber furnish* and *furnish development* at various ply levels in the web of board
- S = *stiffness* and *strength* of the finished coated board—suitable for the end product to be made of the finished coated board (the *density* of the coated board is included in S)
- U = a coated surface *useful* for various kinds of printing and varnishing, foldable without cracking, capable of being glued at high speed—as in containers and folding cartons
- R = the *response* of the coated board to the mechanical forces applied to finish the coated surface
- Kc = *a constant* assigned to the quality of the coating mixture

These seven attributes interact when the web of freshly-made-and-coated board is finished, as by calendering before or after the coating mixture is applied to the web of board, or both. As a mathematical gesture, please consider the following "coating equation" set up to express the inter-relationship between the attributes. This is an equation of condition.

$$R\left(\frac{T+Fd}{C}\right) Kc = (S+U) =$$

(the quality of coated board produced)

In this equation, unity is assigned to each major symbol or quantity, e.g.,

$$R = 1,\ Kc = 1,\ \frac{T+Fd}{C} = 1,\ (S+U) = 1$$

A coating mixture of excellent satisfactory quality, with which it exercises its full capability in the equation, is assigned a Kc value of unity, 1. No matter how satisfactory may be the other terms in the equation, they cannot remedy the defects of an unsatisfactory coating mixture. A coating mixture with Kc value of 0.75 or 0.50, for example, degrades the product of the equation.

Similarly with R, the response of the coated board to mechanical forces applied to finish the coated surface. Here, as with Kc, any response short of unity lowers the quality of the coated board. By response is meant that working, shifting, and fitting together of the structural parts of the fibrous multi-layered board and the layer of mineral coating composition on the top liner of the board—that cooperating of parts, materials, and process steps which leads to the satisfactory product.

$(T + Fd)/C$. The first part of this quantity is the thickness quality, T, of board as compared with the thinness of paper, divided by C, the compressibility of board when calendered; T/C might be substituted for by a quantity indicating the effect of response R on caliper changes caused by excessive calender nip pressures and actions. In a desirable coated board there should not be used calendering action so severe that excessive decreases in board thickness and stiffness occur, along with other undesirable results. If, in an attempt to obtain an exemplary finish of coated surface, severe and excessive calendering is resorted to, whether by excessive calender nip pressure, too many nips used, excessive moisture in the board, kind of calender stack, etc., then the compressibility figure C will increase and the quantity T/C will decrease below unity. Thus the result of the "coating equation" will be lower and will represent a coated board of inferior quality.

We must add to the first part of the quantity—the thickness quality, T, another factor Fd which influences T. Fd is the board furnish and its development (beater and refiner-wise) at the various levels or layers of fibrous stock throughout the board. It is difficult to rationalize mathematically about Fd, except to point out that it may be a positive or negative quantity and thus add to or subtract from T. This is to say that some combination of conditions embracing furnish, kind of fibers used, degree of development, etc., may produce a board more or less susceptible to the compressive and smoothing influences of the calendering action employed in the board-making, coating, and finishing procedures. Thus the sum of $T + Fd$ may decrease and thereby cause a decrease in $(T + Fd)/C$ to below its required value of unity in the coating equation.

Turning now to the product $(S + U)$ of the equation, the sum of S and U ideally is unity, representing a finished coated board having S, stiffness and strength, suitable for the end product to be made of it, and U, a finished coated surface useful for various kinds of printing and varnishing, foldable without cracking, gluable at high speeds, as required in containers and folding cartons. Implied in S is a coated surface with desired color, brightness, opacity, gloss or non-gloss, light-fastness, etc.

Further study of the "coating equation" shows that the terms in it not subject to easy control have the common quality of being involved in a calendering operation; these terms are R, C and T—T because of the necessity of preserving a specified thickness of finished coated board. This raises the problem how to control the calendering operation to obtain the maximum of surface finish on the layer of coating with a minimum effect or decrease of thickness of the coated board.

Do means exist whereby the smoothing effect of the calenders can be confined to the surface of the layer of coating on the board or to the surface of the layer of coating plus the underlying surface of board? What physical attribute of paperboard and its layer of mineral coating must be employed as means? *Plasticity*—used in a broad sense—is that attribute.

One definition of plasticity by Webster is "Capability of being molded, formed, or modeled." Here, then, is the key to the "coating equation," the factor included in several of its terms. If plasticity is lacking or minimized in one or more of the pertinent terms it must exist or be increased in the remaining terms.

Plasticity in useful amount is absent in rigid dry paperboard. Ordinary dry calender stack finishing merely compacts the web and mashes down the high spots. Supercalendering will crush, compact and smooth the board at great expense of thickness, stiffness, color of surface, etc. Similarly, the calendering of dry mineral coating on dry board is ineffective; to the lack of plasticity in the dry board is added the lack in ordinary dry coating.

At the other extreme is a near-damp board with near-damp coating on it; here excessive plasticity exists. It is likely that supercalendering will be inoperative and that ordinary calendering will cause crushing and excessive loss of thickness and stiffness, and that discolored although very smooth plain and coated board surfaces will be produced.

Somewhere between dryness and near-dampness in a mineral coated board to be finished by calendering are six plasticity conditions available for use in the "coating equation." These conditions are located in two zones or phases and are (1) body zones; and (2) surface zones. Body zones include the body of the paperboard and of the layer of coating; the surface zones include the uncoated back liner surface of the board, the top liner surface of board underlying the coating, the bottom surface of the layer of coating against the board and the outer surface of the layer of coating.

Multiple advantages from calendering accrue to coated board containing the two zones of plasticity when optimum plasticities prevail therein. At a given level of calendering intensity the less plastic bodies of the web of board and of the layer of coating are leveled and evened without excessive distortion while the superior plasticities of the several surfaces of the board and its coating layer favor the production of surfaces of high smoothness, flatness and evenness—particularly of the coated top surface and of the uncoated back surface of the board.

One can only speculate about the actual plasticities existing in and on board being coated, dried, then finish-calendered continuously on the board machine. A related question, which I will not attempt to answer, is how to measure those plasticities in their several locations or zones in the coated board—how to measure the flow or motion of a layer of coating on the surface of a web of board, and of the underlying board surface, etc., while the web is being subjected to the nip forces imposed by the stack of heavily loaded revolving finishing calender rolls. It is known, however, that machine coated board, calendered directly from the board machine in hot "dampish" condition responds better to the calendering process than if it is reeled up uncalendered, stored for an indefinite time, then is unreeled and finish-calendered,—this despite the equalizing of moisture content throughout the rolled-up web along with its consequent equalizing of plas-

ticities in their respective zones, with the passage of time stored. Again, it is known that treatments can be given to board and/or to the coating mixture to enhance their plasticities and to further improve response of the coated board to calendering. All these conditions and treatments which improve the calendering of coated board presumably do so by making available more favorable plastic conditions throughout the coated web to be calendered.

The relative effectivenesses of some plasticity zones would seem to vary with the thickness of the layer of mineral coating—the coating coverage—on the board. The academic question persists whether the low coat weight applied by some machine coating processes should be termed a surface sizing or a true coating. Certainly, with very thin coating layers the effectiveness of plasticity interior of the layer is less distinguishable from the surface plasticities of the layer than when thick. Then, too, the plasticity of the fibrous surface of the board interface between a thin layer of coating and the board is even more important than with a thick layer. It would appear, also, that with a thin layer of coating the normal effect of calendering would prevail on the uncoated fibrous back liner surface of the board more so than with a thick layer.

In this discussion I am not referring to any particular on-the-board-machine coating process; the implications of plasticity reside in all of them. Mineral coating mixtures commonly are applied to the traveling web on the board machine from positions located in the drier roll section for one process to positions following it for other processes. A common feature of all these loci is the presence there of ample plasticity in the coated web or the opportunity for setting up conditions of ample plasticity later so that the best possible calender finish is obtained. The "coating equation" responds to the plastic conditions present in the web on the board machine from that place on the drier roll section where the drying web has assumed its identity as a solid but plastic structure to the finishing calender stacks where the nip roll action is facilitated by providing ample plasticity in the dried coated web.

Thickness is an exacting dimension of paperboard, coated or not coated, ranking with weight per unit area in importance, and being as important as surface finish—perhaps more important in some instances. The carton industry wants a rigid, not a flimsy, carton and generally and correctly associates thickness with rigidity and stiffness. The yield of cartons per ton of board is important, too, and the higher the yield the better. Where unrestrained calendering is employed to finish the coated surface—unrestrained to the point of significantly reducing the thickness of the board—decreased board stiffness and loss of carton rigidity occur along with an increase in board density and the need for increasing the substance of the board if the specified thickness is to be maintained. This is the price paid if unrestrained calendering is used to produce a finished coated surface with desired smoothness, levelness, texture, etc. The alternative is to assist the calendering operation by making full use of plasticity in the process of coating and finishing the web of board on the board machine.

Let us study again the right-hand side of the coating equation—$(S + U)$

- S is a coated board of adequate stiffness, density, and strength, suitable for the end product to be made of it
- U is a coated surface useful for various kinds of printing and varnishing, foldable without cracking, and capable of being glued at high speed, as in folding cartons and containers

The sum $(S + U)$ in the ideal coated board is unity—perhaps best expressed as 100, meaning that the several desirable attributes of the coated board add together to perfection, which is a quality never reached.

If excessive calendering action is employed with the object of improving the printability of the coated surface (U) by increasing its smoothness then the component parts of S, — stiffness, strength, and density — are changed in the negative direction; stiffness is decreased, strength is changed needlessly, and density is increased. It is not likely that U, the printability, will be so much improved and increased that the decrease in S will be compensated. Similarly, properties like foldability and gluability are not sensitive to improvement by changes in the calendering of board once a reasonable quality of smoothness of board surface has been reached.

There are four essential steps for the production of high quality mineral coated board on the board machine. They are:

1. Paperboard of proper quality is made.
2. Mineral coating mixture of proper quality is made.
3. Conditions responsive to the best use of plasticity and plasticity zones in the mineral coated web are provided.
4. The board web is coated, dried and calendered while under the influence of the plasticity conditions (3).

Steps 1 and 2 are complex in their own right and have been the subject of many investigations. Color, brightness, furnish, strength, stiffness, etc., of paperboard are specific requirements; to these cleanliness of stock must be added as an exacting requirement because the show of dirt, fiber bundles, shives, rubber, etc., in the board—even in its filler—though the coated surface is caused by the calendering process, particularly with thin coatings.

Step 3, the providing of conditions responsive to the best use of plasticity and plasticity zones, deserves extensive discussion of itself. Suffice it to say that the board machine calender stacks with their water boxes, and the use of water solutions of selected substances in those boxes or elsewhere in the travel of the board web provide plasticity controls which can supplement the plasticity of the board web and of the coating mixture. Step 4 is self-explanatory.

Early in this discussion I presented an item 3, being the end use requirements of the coated board as in the printed folding carton or container. Item 3 remains to be discussed. Questions of plasticity are involved to the extent that they have assisted the production of a suitable coated board. This discussion will be a recital of the successive stages in the life of coated board in the form of, say, a folding carton. Like the popular radio program which describes Inco nickel as the unseen friend in articles made of certain metal alloys, so is plasticity in its various guises, an unseen friend contributing to the good qualities of cartons made of mineral coated board. I beg the indulgence of the board or cartonmaker to whom this recital will be an old story but am hopeful that it will be informative to others.

Once the coated board has been made, with due regard to its specifications and economy, it is delivered to the converting department—the carton plant—as a roll of board or pile of sheets. Here the coated board must survive the rigors of printing, cutting, scoring, folding, and side seam gluing only to be subjected next to abrasive and smearing forces as the folded cartons, packed flat in bundles or shipping containers, rub upon each other while in transit to the carton user. The user, say the maker of soap granules, feeds the folded cartons into a filling and sealing machine, operating at high speed, where each one is opened into box form, its bottom set of carton flaps is sealed with water-base adhesive, the soap product is run in, the top flaps of the carton are closed and sealed with water-base adhesive, and the filled sealed cartons are loaded into containers for shipping to the warehouses whence to the sales outlets.

En route to the sales outlets the coated surfaces of the carton again have opportunity to punish each other by rubbing together, plain to plain coating where unprinted surfaces coincide, also printed to plain, and printed to printed, and the bad effect of rubbing may be aggravated by the chance presence of dusty product spilled or sifted onto the carton faces. The plain coating must not rub off or become dusty nor the ink smear lest the printed illustration and reading matter on

Junior Award Contestants and Chairman: N. F. Rauscher, Diamond Match Co.; Maung Mai Aung, St. Regis Paper Co.; W. R. Willets, chairman; and Donald Anderson, International Paper Co.

the carton become marred, not only to close inspection but when viewed en mass on the retailer's shelf.

Finally, the filled printed carton made of coated board reaches its destination—the purchaser's home, perhaps his laundry—where the coating dare not fail by rubbing off or by releasing printer's ink should it become damp or wet with water. It is curious that water, which played so prominent a part in inducing the plasticity so valuable in the coating process becomes a threat to the carton at the end of its life.

For the sake of completeness it seems desirable to add to this discussion something about the printing and varnishing of mineral coated board. Here, again, an equation of condition can be set up to express the complementary aspects of the coating on the board and the printing or varnishing of the coating, as with oil or varnish base inks on a printing press. It is, perhaps, far-fetched to assume that the plasticity conditions employed in the coating process retain any potency by the time the coated board is printed but, nevertheless, they do influence the printed sheet by making one which prints satisfactorily.

The mineral coating on board and the printing of the coating are complementary to each other. The quality of printing obtainable on the mineral coating on a given coated board is influenced by the nature of that coating and the nature of the printing ink used. Similarly, the quality of printing required to be done on a coated board dictates the type of coating mixture to be used, its composition and, perhaps, its method of application to and finishing on the board.

Three factors cooperate to produce a satisfactory quality of printing on mineral coated board. Their cooperation may be expressed by this equation of condition for the printing of coated board:

Coated board plus ink plus printing procses =
100 = the satisfactory printed coated board

Expressed by symbols this reads:

$$CB + I + P = 100 = \text{the printed product}$$

Here, P, the printing press, is less variable than the coated board or ink (on a given press or in a kind of printing process) hence P may be omitted from our considerations or may be assigned a fairly constant value K. The equation then becomes

$$CB + I + K = 100$$

Study of the revised equation in light of practical experience reveals:

A. There is a minimum value assignable to each left hand term below which the term becomes valueless and the equation inoperative.

B. At or above the minima, the deficiencies in one term may be compensated for by the plus values of the other term (K being kept constant). This means that moderate deficiencies in the quality of coated board surface in a certain respect may be remedied by using an ink of better than usual quality in the same respect. It also means that a completely unsatisfactory quality of coating on board cannot be printed satisfactorily, no matter how excellent an ink is used. It means, too, that the coating and ink must be selected to cooperate to produce the desired printed result, e.g., coating formulated to print flat must be printed with "flat" ink; one to print glossy, with gloss ink; etc.

Thus we can add to the "coating equation" another one expressing the printing of the coated board.

Printing of Paper by the Lithographic Process

Ray Shalvoy

THE lithographic offset process is based on the principle that water and grease are immiscible and this concept has held since the invention of lithography by Senefelder in 1798. The offset principle was introduced in 1904 when it was discovered that a smoother, sharper impression was received in transferring from the plate to a smooth rubber blanket and then from the blanket to the paper. Since better tone values and half tone reproductions developed by use of the offset principle, it grew rapidly and expanded into fields that were normally done by other methods of printing. However, with this new process certain problems developed and have remained with lithographers to this day.

Paper troubles encountered by the lithographer can be classified into two general groups: printing troubles and register problems. We will discuss some of these problems and the reasons for their existence. First I will present a general explanation of the offset process.

Figure 1 is a cross section of the first unit on a high speed 72-in. Harris four color offset press and illustrates how a sheet is printed by the offset method. The sheet lifts from the feed pile by a series of air suckers and is transferred to the feed table, from which it is picked up by the register cylinder. Because this is a high speed press capable of running 6000 sheets per hr. it is necessary to have the sheets moving down the feed table overlapping each other. The function of the register cylinder then is to pick the sheet from the feed table and remove it in time for the next sheet. The adjustment cylinder, sometimes termed the intake transfer cylinder, passes the sheet from the register cylinder to the impression cylinder. While on the impression cylinder the sheet receives the printed image from a smooth rubber blanket mounted on the blanket cylinder. The printed image on the rubber blanket was obtained from the inked plate on the plate cylinder.

After leaving the impression cylinder it passes to the transfer drum and is carried to the next unit. Inking of the plate is accomplished in two successive steps on the lithographic press. As the plate cylinder rotates the plate is brought in contact with the form rollers of a dampening system. These rollers leave a thin film of acid fountain solution on the nonprinting areas of the plate. Some of the water film on the plate eventually reaches the paper surface via the blanket and this is important when considering the properties for offset papers. I will refer to this later in the paper. Following this the plate comes in contact with the form rollers of the inking system. These rollers deposit the printing ink on the image areas of the plate. To obtain the strength required in the printed film, offset inks must be more highly pigmented than other inks. This high pigment content increases the viscosity and the tack in the offset ink over that found in letterpress or gravure inks. This coupled with a rubber blanket impression media that has a tacky surface itself, creates the need for paper with certain properties built into

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it. The water for the plate is usually a dilute acid solution. Some of this film of water is transferred to the paper surface via the rubber blanket and because of this certain other qualities must be present in paper for use in offset lithography.

I would like to discuss now some paper problems encountered by the litho process.

We can class paper problems into two general groups: no. 1, printing troubles such as picking and splitting of paper,

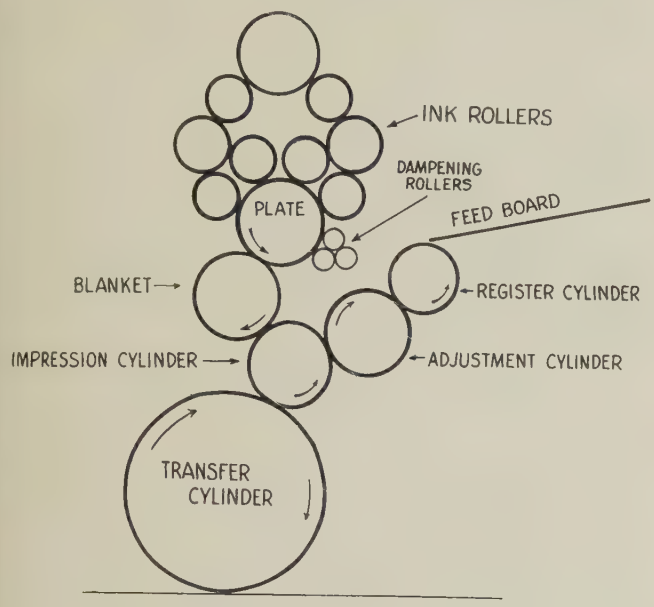

Fig. 1

presence of lint, chemical reactions which cause plates to become ink receptive in nonprinting areas, failure of ink to dry properly due to chemical action of the paper, and surface properties of coated paper that may cause a "wash-off" of material to the blanket. Number 2, register troubles are due to some undesirable condition of the paper. We will not consider improper mechanical press adjustment at this time as a cause of sheet misregister but will confine our comments to those factors in misregister due to paper.

Let us now consider the printing problems just listed in more detail and illustrate the ultimate results of these problems on a lithographed sheet. Picking usually results in a coated sheet due to weak adhesive properties between the coating and the raw stock. If a certain coated paper has been established as standard for specific jobs and an order gets to press that is below standard in pick resistance, invariably trouble will develop due to picking off of the coating. This usually takes place along the "leave-off" or back edge of a solid impression and is illustrated in example 1.

In this first example the blue you observe is due to coating picked on the yellow "leave-off" and transferred to the blue blanket, and this coating on the blue blanket transfers to the blue plate causing blue to print along the back edge of the yellow. When this condition develops it necessitates shutting down the press to wash the blankets and plates, which is costly and reduces production rates. It also adds to color variation throughout a run since starting and stopping a press for wash-ups will cause variation. Reducing the tacks of inks by addition of a tack reducer, such as boiled oil or refined kerosene, will aid in the elimination of the tendency to pick, but other troubles will develop. In reducing the ink's tack a lithographer will also reduce the strength of the ink. This forces him to apply a heavier film of ink to match shade in the solid areas. This will increase the tendency of the ink to offset to the sheet above it in a pile, and will cause the ink to fill in more readily in halftone areas. If ink tacks are not reduced properly in four-color press work a loss of good trapping will also result. Trapping is the ability of a first color down on a multicolor press to "trap" or receive succeeding colors on it.

Splitting of paper is serious because a much larger segment is separated from the sheet and clings to the blanket. When a piece of material stays on the rubber blanket there is a possibility of ruining the blanket if the split piece of paper folds over and causes excessive pressure on the blanket, breaking its surface. This is very costly both in press down time and material cost of the blanket. Splitting usually results from weak internal strength in the raw stock that cause it to give way because it will not stand the force exerted in separating the sheet from the blanket after it has been printed. When this state is reached the sheet splits and part of it remains attached to the blanket.

The presence of lint in an offset sheet is disturbing because it travels from the sheet surface into dampner rollers and up into the ink rollers causing an accumulation of material that is difficult to clean without washing up the entire press. Lint also adheres to the blanket and eventually shows in slid impressions on the sheet as fine pieces of fuzz.

The use of an acid fountain solution on the lithographic plate imposes severe restrictions on papers for the offset process. It is essential that the surface of paper for offset be considerably water insoluble. In the case of coated papers the coating adhesive must be fairly water resistant. Otherwise the coating pigment will transfer to the blanket and build up an abrasive material that will eventually sensitize the plate and cause it to print in nonprinting areas. Another chemical factor that must be considered is the pH of the paper surface. We have found that a paper with a surface pH of 5.0 or below will give us drying trouble with our inks. Apparently the low pH tends to deactivate the dryers in the inks resulting in the need for a longer period of time to dry the ink film.

The second major problem listed was register trouble due to some undesirable condition of the paper. Register may be defined as exact correspondence, as in the positions of printed colors in multicolor printing. Example 2 illustrates the effect misregister has on a reproduction. Observe that the dark blue color is out of line over the medium blue in the lettering and the red color is out of line over the yellow color in the lettering. If the colors were properly in register you would not see any medium blue or yellow in the lettering. Also note the hazy or blurred appearance in the pineapple when compared to the label that is marked "in register." This illustration shows what a reproduction will look like when colors do not register as compared to how the same reproduction looks when all colors are in register.

I will discuss the three requirements that paper for offset should have to eliminate register problems. The first of these is that the paper should be perfectly flat. In receiving the offset impression the paper must pass between the blanket and impression cylinder where it undergoes a uniform squeeze of about 40 lb. per in. along the impression line. Unless the sheet is perfectly flat it will be distorted while being printed and in so doing succeeding colors will not register properly on the color that was printed on the distorted area.

The second requirement is that the gripper edge and side guide edge of all sheets for an offset press should be trimmed straight and square. On the diagram of the offset press you will observe that the sheet travels down the feed table to the register cylinder. The front of the sheet is picked up by a set of grippers along the impression line of the register cylinder. This front side is called the gripper edge of the sheet and if it is not cut straight and square to the side guide edge it will not meet the cylinder correctly for proper register. The side guide edge is the left hand edge of the sheet as it enters the press and is so called since it is along this edge that the sheet is lined up for proper contact with the register cylinder by means of a metal guide on the feed table. If the sheet is not cut square on these edges it will enter the register

W. E. Anderson, Riegel Paper Corp.; and Ray Shalvoy, Stecher-Traung Co.

cylinder at an angle and cause the sheet to print out of register.

The third requirement for good register is that there be a lack of serious dimensional changes in sheets to be printed. One property the paper must have to insure against this is a uniform moisture content throughout the sheet. We have found that in an air conditioned press room with a relative humidity of 45 to 50% and a temperature of 70 to 75°F. a litho sheet will pass through a four-color press without serious register trouble if it has a uniform moisture content of 5.5 to 6.0%. At this point I would like to emphasize the necessity of having moisture uniformity throughout the sheet. If the sheet has a moisture content of 6.5% on the gripper edge, 5% moisture content in the center, and 4% moisture content on the back edge we are certain to have register trouble. A sheet of this nature will have wavy edges on the gripper and be tight on the back edge. It would have stretched and expanded on the gripper because the high moisture content swells the fibers in the sheet while the back edge would have shrunk in comparison to the gripper edge since fibers with a 4% moisture content would not swell as far as those with a 6.5% moisture content. Paper in this condition will print large on the gripper and small on the back edge and subsequently cause misregister.

When this condition develops certain adjustments can be made on the press cylinder to compensate for it, but only within limits. They can be made only if we know every sheet will have the same lack of uniformity from gripper to back edge. This, of course, does not exist and results in a high waste factor once the job is completed as the misregistered sheets cannot be used.

There is a difference that exists between printing on a 22 by 34 in. two-color press and printing on a 50 by 72 in. four-color press. A paper that operates well on the small press will not necessarily perform well on a large four-color press. There is naturally more tendency for the sheet to pull, weave, and misregister on a 72-in. press putting down four successive impressions at one printing. The register across the sheet is more critical since a greater area is covered and a greater pull is exerted on the sheet as it separates from the blanket impression.

This greater pull coupled with four impressions at one printing means a sheet for a large four-color press should be constructed with more internal strength and be more dimensionally stable than paper made for a smaller one or two color press.

At the present time we feel that the paper industry has done a great deal towards producing paper with good ink receptive properties and surface improvements such as smoothness, gloss, and brightness. We would like to stress that there be more control and development on the mechanical properties of the paper such as the following:

1. Better dimensional stability throughout the sheet.
2. Proper moisture content and uniformity of moisture content throughout the sheet.
3. Elimination of slime spots and dirt.
4. A stronger sheet internally that will be less prone to picking or splitting and will lie flat.
5. More uniform basis weight control through the sheet.

All of these will aid in providing better uniformity throughout press runs and will decrease press stoppages which will result in less waste and increased production.

The reason I express our concern over the need for further study along these lines is that we have found a continual rise in the cost of materials for the lithographic industry which cannot be reflected in the sales price of printed matter. To allow for this increased cost of material we must find ways to cut waste and increase production if we are to exist.

Solvent Coating, Laminations, and Pasting

W. E. Anderson

Paper has a wide variety of uses in many fields but is lacking in some functional properties for specialized applications. The paper converter takes paper and by use of solvent coating, laminating, and gluing has been able to impart the functional properties necessary for specialized uses. He has been able to impart heatseal, water vaporproofness, greaseproofness, transparency, chemical resistance, and various other special properties.

The converter started years ago with printing and waxing of paper. Today, he has expanded his operations to include not only printing and waxing but solvent coating, extruding, film laminations, foil mountings, and hot melt coatings. The continuing growth of the flexible packaging field has steadily demanded new converted paper products and the converter is continually working to produce new and better packaging papers.

I will endeavor to explain some of the basic materials and processes used by the converter to produce these products. This discussion will, of course, be fundamental and general as there are many special techniques used and an unlimited number of formulations for solvent coatings, adhesives, and laminating agents.

Solvent or lacquer coatings are formulations of film formers, resins, and plasticizers dissolved in suitable organic solvents to make a solution. The film former can be any of the cellulose esters or ethers, vinyl polymers and copolymers, natural or synthetic rubber, acrylic polymers, shellac, and many others. The resin is hard to define as there is today a wide choice of synthetic resins available. Years ago, we were limited to a very few synthetic resins and were mainly dependent upon natural resins and gums which, besides being in uncertain supply, were not uniform. The plasticizers are generally liquids that are compatible with the film former and resin. For example, organic phosphates, phthalates, and glycolates can be used.

The choice of organic solvents to use in a lacquer formulation is dependent upon several things. First, a quantity of active solvents for all the ingredients should be used. Second, if solvent recovery is to be used in connection with the lacquer coating equipment, the solvents used should be recoverable and have a minimum number of components. Third, it is usually desirable to use solvents which yield low viscosity solutions, and fourth, the solvents used must evaporate during the drying operation in such a manner as not to cause

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precipitation of any of the dissolved solids, or cause the phenomenon known as chilling or blush.

Let us consider for a moment chilling and blush. If, for example, nitrocellulose is dissolved in a solvent, such as acetone, and the lacquer solution applied to paper, the acetone on evaporation tends to lower the temperature of the lacquer film and of the air in its immediate neighborhood to below the dew point of the atmosphere, this being caused by the excessively high evaporation rate of too volatile a solvent. The chilling is characterized by the early appearance of cloudiness or opacity in the film.

Besides active solvents, diluents are generally added to lacquer solutions to reduce cost. The diluent being a nonsolvent for the film former must be carefully chosen. It is necessary to use one that has a higher evaporation rate than the active solvent in order to ensure that at no instant will the ratio of it to solvent be in excess of that at which either the film former, resin, or plasticizer begins to be thrown out of solution. Generally speaking the higher the concentration of solids the smaller the ratio of diluent to solvent permissible. If it is desired to use the maximum proportion of diluent it is advisable to employ a mixture of solvents whose boiling points increase progressively, but it should be borne in mind that increase in boiling point is generally accompanied by decrease in solvent power. For the same reason it is undesirable to use mixed diluents, a single diluent of suitable vapor pressure being the best, the vapor pressure of this diluent being greater than that of any of the active solvents but sufficiently low to avoid chilling.

If a volatile diluent is mixed with a volatile solvent, the boiling point of the mixture may be lower than that of either, and the ratio of diluent to solvent which evaporates may, in consequence, be affected. Such azeotropic mixtures, as they are called, are quite common and may tend to cause blush and require the incorporation of higher boiling solvent.

Active solvents vary in solvent power, diluents vary in precipitating power, and the line of demarkation between active solvents and diluents is not clearly defined. The type of film former being used plays an important part. For example, there is a grade of nitrocellulose that is soluble in ethanol and another grade that is insoluble, so that ethanol can be either a solvent or a nonsolvent depending upon film former.

The solvents used in making up the lacquer play an important part in the viscosity of the solution. In general, the greater the vapor pressure of the active solvent, the lower the solution viscosity. The substitution of a nonsolvent or diluent into the system may increase the viscosity but sometimes will give a solvent mixture having increased solvent power. Consequently no hard and fast rule applies. In certain cases the substitution of a nonsolvent in small proportions reduces viscosity whereas higher proportions increase the viscosity until a point is reached where further substitution causes precipitation or formation of a gel. Viscosity is an important measurement in lacquer work; in fact, many film formers are classified and sold under viscosity specifications.

The evaporation rate of a solvent is very important and is governed by several factors, the most important are: (1) vapor pressure of the liquid at the temperature under consideration; (2) rate at which heat is applied; (3) specific heat and heat conductivity of the liquid; (4) degree of association of the molecules; (5) molecular weight; (6) the rate at which the vapor adjacent to the solvent is removed; and (7) humidity of the atmosphere. With mixtures of solvents two additional factors must be considered. (1) the molecular attraction of one component for the other and (2) the depression of vapor pressure of one component by another. The problem is complex and as yet cannot be accurately evaluated.

With this background on solvents let us proceed into the type of lacquers presently used and point out the properties of the coatings.

By far the most widely used lacquers are formulated with a nitrocellulose base. These lacquers can be made heatsealable if properly plasticized. They can also be made water vaporproof by using small percentages of paraffin wax in the lacquer. They are greaseproof, possess good gloss and scuff resistance but will turn slightly yellow on prolonged aging especially if exposed to sunlight.

Cellulose acetate formulations are generally used to impart grease resistance. The coatings are not particularly good for water vaporproofness or heatsealability. They have good gloss and scuff resistance as well as aging characteristics.

Ethyl cellulose lacquer films when properly plasticized have good heatseal, the film has good gloss, scuff, grease, and alkali resistance by cannot be made as water vaporproof as the nitrocellulose types.

The vinyl polymers and copolymers can be formulated into a variety of slightly different lacquer coatings. They can be made heatsealable but are not particularly good for water vaporproofness. They have good grease resistance, scuff resistance, gloss, and aging characteristics and fair acid resistance. Vinyls can be formulated into organosol and plastisol coatings. The organosol differs from a regular solvent coating in that the quantity of solvent used to formulate the lacquer is very small and not an active solvent at room temperature. A plastisol uses no solvent but is a fine dispersion of the vinyl in plasticizer. Both of these special types of coatings require grinding equipment for preparation, such as pebble mills, rod mills and the like for finely dispersing the vinyl into either the solvent or plasticizer.

In the natural and synthetic rubber coatings we find cyclized rubber, chlorinated rubber, and butadiene-styrene copolymer coatings. The cyclized rubber and butadiene-styrene copolymer coatings have excellent water vaporproofness and heatseal, leading all other solvent coatings in water vaporproofness. The chlorinated rubber coatings have good heatseal but at the present time are not as good in water vaporproofness. They are all less grease resistant than the vinyl and cellulosic coatings.

There are, of course, many other types of coatings used today, like the epoxy resins which are currently being extensively investigated, polyamid, urea-alkyd resin combinations to name only a few. Time does not permit evaluation of all of them so I have only mentioned the most widely used materials.

How are these lacquer coatings applied to paper? There are two basic pieces of equipment used for this work: the roller coater for application of thin coatings, and the reverse roll coater for application of heavy coatings. The roller coater is composed of two chilled iron rolls mounted one above the other with the paper to be coated going through the nip. This equipment will apply coatings from 1 to about 15 lb. per 3000 sq.ft. ream applying the coating equally on each side of the paper. It can also be used for one side coating.

The reverse roll coater consists of two chilled iron rolls mounted in an off vertical axis. Under the bottom iron roll is generally a synthetic rubber roll over which the paper is carried. In the nip of the chilled iron rolls are dams which hold the lacquer solution. The surface rotation of this bottom roll or casting roll is opposite to the paper travel. The top chilled iron roll, called the doctor roll, meters the desired quantity of coating onto the casting roll. The casting roll then applies the coating to the paper by wiping the paper. Reverse roll coaters apply the coating to one side of the sheet only and if two side coating is necessary it means two passes through the unit, one pass for each side. These units are capable of applying coatings of several mils in thickness.

In both the roller and reverse roll coating it is necessary to have very accurately ground roll surfaces. Tolerances of 0.0001 in. are necessary for good coating work and if these tolerances are not held there will be variation in the thickness of the coatings applied.

After either of these coating heads comes the hot air oven for evaporation of the lacquer solvents. The ovens used forced hot air for drying. The air is heated by a variety of

means, steam heat exchangers, oiled fired hot air furnaces, electric heat, and gas fired units. The ovens are usually divided into several zones with automatic controllers for heat regulation. It is necessary to control the heat in order to properly dry the lacquer through controlled evaporation of the solvents. If too much heat is used initially the lacquer may skin dry making further solvent removal difficult if not impossible without the formation of bubbles or blisters. So much for solvent coatings.

Laminating and pasting or gluing are methods used to combine two or more sheets together. The webs combined may take a variety of forms being combinations of papers, foils, and films. The type of material used to laminate depend upon the desired characteristics in the final product and the webs being used. The possible combinations are almost infinite and therefore it will be impossible to cover all of them. I will discuss wax lamination, glue lamination, solvent adhesive laminations, and lamination by polyethylene extrusion.

Wax lamination is generally used in combining two sheets of paper. Usually microcrystalline waxes are used because of their inherent sticky nature. These waxes are fairly cheap and give good water vaporproofness properties to the laminated web. If improved bond is desired the microwax can be modified with materials such as vistanex, butyl rubber, resins, and plasticizers to obtain any desired bond strength.

In application the molten wax or wax mixture is applied to one side of one of the webs to be laminated either by a squeeze roll or other type of application. The second sheet then is brought in contact with the waxed sheet by means of a pair of nip rolls and the lamination made while the wax is still in a molten condition.

The WVTR of the laminated material will be dependent upon the type of papers laminated, quantity of laminating agent used, and type of laminating material. Naturally hard dense papers such as glassine stocks will afford better WVTR than will porous kraft papers. Increasing the wax weight will improve the protective qualities of the laminated material. Microcrystalline wax will give better WVTR than asphalt which is commonly used on heavy weight papers as a cheaper material than the waxes. Asphalt is limited in its use as both odor and color automatically eliminate it from food packaging papers.

Aluminum foil is sometimes combined to paper with a wax laminating agent. This combination has excellent water vaporproofness.

Glue laminations are frequently used in combining foil to paper. Most laminations are made using water emulsions of vinyl acetate, synthetic rubber, and combinations of the two. It is general practice to apply the water emulsion to the foil then laminate it to the paper. The reason for applying the glue to the foil is twofold, first the adhesive will not soak into the foil and second, the final lamination tends to curl less. It is necessary to dry these adhesives after the lamination to the paper has been made. Insufficient drying of the adhesive will cause the foil to corrode upon several weeks standing. The corrosion usually starts at pinholes in the foil and gradually expands over the surface of the foil. Even with excellent drying facilities on a glue laminator the foil is subject to corrosion on prolonged aging especially if kept at high humidities.

The water-base glues are readily applied to the foil by means of an etched roll or gravure roll followed almost immediately by a pair of nip rolls. The nip is preferably a steel roll-rubber roll combination and the paper is fed in at this point. After the nip the laminated web passes into a hot air oven or under radiant heaters or some other drying equipment.

Solvent laminations are generally made in a similar manner, however, the nip rolls follow the drier instead of preceding it. Generally the solvent adhesive is applied to the foil or film and passed into the drier. Upon leaving the drier the foil or film is fed into a hot nip composed of a steel roll-rubber roll combination. At this point the paper is fed in and the combination is heat and pressure welded together.

There is an infinite variety of solvent adhesive formulations in use today. They range from solvent solutions of plasticized vinyl resins to solvent solutions of natural and synthetic rubbers. The choice of the particular adhesive to use is dependent upon the materials being laminated. Today aluminum foil, cellophane, pliofilm, cellulose acetate film, polyethylene film, polyester, vinyl films, and the like are all being used in solvent lamination work, not only in combination with paper, but with each other.

Recently, polyethylene has been used as a laminating agent for paper and foil. This technique involves the use of a polyethylene extruder with double unwinds for each side of the polyethylene die. The paper and foil are fed into the nip of a rubber roll-steel roll combination and the polyethylene extruded between them. This technique is applicable to other combinations such as paper to paper, foil to foil, and many others. This type of lamination has a particular advantage over that of solvent or glue lamination in that polyethylene will give moisture vaporproofness to the laminated materials and glue and solvent adhesives will not. I can forsee a wide application for this type of lamination. With it the converter need not worry about corrosion of foil or trapped solvents from adhesives to give odor difficulties. He now will be concerned about maintaining good bond between the polyethylene and the base webs used. The converter goes from one problem to another step by step with ever increasing headaches, however, his satisfaction comes in knowing that he is producing better products for the packaging industry.

New England

The following paper was presented at the annual meeting of the New England Section, Magnolia, Mass., June 2, 1955.

Development of a Quality Contol Program

C. M. Howell

As some of you gentlemen may know, my paper mill experience has been in toilet tissue and paper towels. I entered this field in 1922, after getting my M.S. degree from the University of Maine. At this time, toilet paper was a very small industry, with little standing. The product is a humble one with very definite and obvious handicaps in the developing of a quality concept and particularly in the development of an advertising program.

They used to tell a story around the mill at Chester, to the effect that A. H. Scott, the son of the founder, attended a meeting of toilet paper manufacturers shortly after he became active in the business, where he suggested that the manufacturers start advertising toilet paper, and was greeted with a very loud "horse laugh." All the manufacturers poohpoohed the idea of advertising this crude, lowly product, thinking it the heighth of ridiculousness. They really gave him the "raspberry" in good shape. I was told that A. H. never attended another meeting of the association, but he went ahead and started advertising Scott products. Now it has always been the belief of Scott Paper Co. and I firmly believe it myself, that there is little gain in advertising unless you have something in the way of quality or price, or both, worth telling the people. Therefore, it became necessary to develop a quality control program that would insure the best and most uniform quality of paper being made, so as to back up the advertising program.

Over the years, I am certain that both successful advertising and quality control has been remarkedly well done at Scott Paper Co. Now, if it is possible to take a simple, lowly

C. M. Howell, Department of Chemical Engineering, University of Maine, Orono, Me.

product, such as toilet paper, and develop a quality program that convinces the entire organization that making a top quality roll of toilet paper is just about the most important thing in life, then it should be possible to do it with any product. Therefore, the story of how this was accomplished might be of interest to other papermakers.

When I went with the company in 1922, the chief chemist was in charge of quality inspection. He examined the jumbo rolls made during the night shift when he came in the plant in the morning. It was said by the operators, that if he felt good, he rejected very little paper, but, if he had had a bad night—look out! The only testing done on the paper was by the assistant chemist who collected back tender's samples that had been saved for him during the night. He weighed and bulked them to check the figures submitted by the machine crews. The operators laughed to me about this, because they said most of the back tenders made up a bunch of samples from a good roll at the beginning of the shift and handed them in as being made from different rolls during the night. In other words, the so-called quality control was meaningless. The management talked a lot about quality of paper, but since they had such an ineffective system for maintaining quality, the operators didn't take quality seriously, because they didn't think management really meant what they said.

Along about 1925 or 26, the company came to realize the weakness of their program and decided to really go after quality control.

A separate department was created and named the consumer's representatives. The idea behind this name, was that the inspectors who inspected the paper for quality defects, were representing the millions of consumers of toilet paper, who could not inspect the paper themselves. The insignia of the new department was a market basket, representing the market baskets of the women shoppers who buy most of the paper. This name turned out to be an excellent choice.

One of the strongest and most promising men from the sales department was selected to be the head of the new department with the title of "chief consumer's representative." He reported directly to the president of the company. He was permitted to hire and train men as inspectors, and inspection was done throughout the 24 hr. This was a new deal indeed.

Certain physical tests were established and made upon the paper at definite intervals throughout the shift. Records of these tests were made and a daily quality report issued. In addition to the tests, the consumer's representatives had full authority to reject a roll, if it didn't measure up. Daily meetings were held at 9 a.m. to examine the reports, and examine small roll samples. One small roll was saved from every set of jumbo rolls. These rolls were placed upon a long bar, so it was convenient for everyone present to examine the sample rolls. These meetings were attended by: the president; vice-president and treasurer; chief consumer's representative; chief engineer; head of technical control; paper mill superintendent; finishing superintendent; and various others.

At first, the method of rating the rolls for quality was quite crude. Each man present was called upon to rate each small roll—1, 2, 3, or 4 for softness and for appearance. While this method was certainly a long way from being scientific, it was probably one of the most effective things ever done to impress quickly and strongly upon the operating organization the fact that the top management of the business *really* wanted quality. To see the president and the vice-president of the company taking an hour or more of their time daily to examine and rate the paper quality of a large number of individual rolls, did more than a hundred talks or reports would have done to convince the paper mill superintendent that he really did have to see to it that his men made good quality paper.

Since the individual rolls were collected by the consumer's representatives, there was no chance for the operators to cheat on the samples.

The small rolls were also examined for perforations, end roll appearance, firmness of roll, dirt, color, etc.

Now, I do not mean to imply that the president and vice-president of a company should spend an hour every day looking at samples of the previous day's production. This, however, was a special case. A new deal had been started and it was an expensive one. The new chief consumer's representative needed all the help he could get to make the new quality program effective quickly. Looking back, I think he accomplished practically a miracle in the speed with which the operating personnel of the company, including the superintendent and all the employees under him, were sold on the overwhelming importance of making all the paper within the quality standards, and that the biggest contribution any Scott man could make to the success of the company was to point out ways to make the paper softer, better looking, cleaner, etc. Probably the main reasons why he was so successful are as follows:

1. He was a very able man, who quickly sold himself to the operators.
2. Reporting directly to the president gave him prestige, authority, and freedom of action, that he could not possibly have had otherwise.
3. The president always supported him in case of difference of opinion upon quality of paper rejected, even though it sometimes meant the loss of several hours production on all the paper machines.
4. The daily meeting of the president and vice-president with the supervisors to discuss quality.
5. The recognition and real authority given to the shift consumer's representative. On his shift, he was really in charge, insofar as quality was concerned.
6. Huge sums of money that were eventually expended to improve the quality of the paper.
7. Incidents such as the decision of the top management to slow down all the paper machines 100 f.p.m. to secure a little softer paper.

Later, a constant humidity room was installed in the paper mill in order to test all samples under standard conditions. A graduate chemical engineer from the University of Maine was made the head of this testing station, reporting to the chief consumer's representative. James Clark, technical director of Scott Paper at the time, developed a stiffness, or, as we called it, a softness tester, which gave a tremendous lift to quality control, because the most important single quality of toilet paper was removed from a matter of personal opinion to one of actual test records, which could be kept and recorded, so that we knew whether we were getting better or worse. Also, results of experiments to improve softness could be more accurately measured and evaluated. I personally believe the development of this tester, while not a 100% measurement of softness, was one of the greatest steps ever taken in the development of the control of the quality of toilet paper and paper towels.

Another step taken that greatly aided the development of a quality program was the establishment of a quality bonus program. The company had had a strong production bonus system ever since 1926, and the quality bonus system did much to interest the operators in doing their best to make every set of paper, not only within the quality standards, but as near the highest levels of quality as possible.

Mr. Wagner, the vice-president, also started the practice of giving a dollar to each member of a machine's crew every day his machine had a perfect day—in other words, no rejections for quality. He also sent each member of the crew a personal letter, thanking them for such a good day's performance. With the strict quality standards and tight control set up by the consumer's representative department, it was not easy to make a perfect run and they were greatly prized by the crew.

To add to the interest of the campaign on quality, pictures of machine crews were taken from time to time, when they had accomplished something unusually good, and these pictures were published in the company magazine.

I have only sketched a rough outline of the quality program that was installed at my old company. One weakness that developed over a period of years of this strong quality control program was due to one of its strongest assets. I refer to the unlimited support given to the chief consumer's representative which, in effect, made him the final authority upon questions of quality. Since the product was sold to millions of consumers who could not speak for themselves about their wishes in qualities of paper, it became a matter of the personal opinion of the chief consumer's representative. These men have been capable men, but they have made mistakes, being human. One chief consumer's representative, for example, liked a very closed sheet of tissue and he forced the making of a sheet much harder than necessary, to satisfy his idea about formation. Eventually, the company recognized this weakness, and set up a second branch of the quality department, called the consumer's research division. This department sends out trained women employees with sample rolls of paper, made with some special quality change from standard. These rolls are delivered to women in a selected test territory, and used by them for a certain period of time. The women research workers then return and secure answers to certain carefully selected and worded questions. The answers to all these questions are summarized and carefully studied.

One of the first things found out by these research workers was that the man who favored a closed sheet at the expense of softness had been dead wrong. The consumer apparently wants softness in toilet paper and is content with a moderately well formed sheet.

During the development and perfection of the Scott quality control, I was in close touch with it, having attended all the meetings upon quality, first as head of technical control, later as engineering manager, and finally as general plant manager. In all these positions, my responsibilities and my sympathies inclined, naturally, to the operating end of the business. I had many disagreements with the chief consumer's representatives about the rejection of paper, and about their insistence upon quality being improved—sometimes when we just didn't know how to do it. I still feel I was right in some cases (the formation previously mentioned, for example) but in general, I firmly believe in a very strong quality program for a paper mill, or any other manufacturing organization, for that matter.

It is my strong conviction that not only did the quality program at Scott Paper Co. result in better and better paper being made, and more and more being sold to the consumers because of this, but, that in the end, we made more and more paper with less rejections than in the beginning, because the high quality standards, with the high rejections resulting, forced us to search out and eliminate the causes of these rejections, and that the improvements in the equipment and methods resulted not only in better paper, but that we made more of it at lower costs. For example, the original pressure inlet was installed on one of Scott's machines in 1934, not to enable us to run faster, but because it improved both the appearance and the softness of the sheet. The higher speed resulting from the use of these inlets was just an extra bonus.

I believe the quality department should not be under either technical control or the production department. To have the chief quality man responsible to the man responsible for production and costs is somewhat like having the umpires in baseball responsible to the baseball managers. Believe me, some of the arguments I have had in the past with chief consumer's representatives have rivaled in their intensity some that Leo Durocher has had with baseball umpires. Yet, I thoroughly believe in the chief consumer's representative having the complete authority to decide quality questions, with the full support of the head of the business, as I am sure Leo would agree that the umpire, wrong as he undoubtedly sometimes is, being human, should have the final say upon baseball decisions, with the knowledge that the president of the league will give him his complete support.

1955–56 Officers of Delaware Valley Section of TAPPI: C. F. Ackerman, Membership Committee Chairman; C. R. Calkins, Program Chairman; G. K. Boger, Jr., Secretary; D. C. Kane, Treasurer; P. E. Nethercut, Chairman; E. R. Padavic, Retiring Chairman.

Delaware Valley

The new Section officers of the Delaware Valley Section of the Technical Association of the Pulp and Paper Industry for the 1955–56 term are:

Chairman: Philip E. Nethercut, Scott Paper Co., Chester, Pa.
1st Vice-Chairman: C. R. Calkins, Riegel Paper Corp., Milford, N. J.
2nd Vice-Chairman: C. F. Ackerman, Union Mills Paper Mfg. Co., New Hope, Pa.

Philip A. Cerasoli receiving the Albert Award plaque from E. J. Albert

Left to right: Walter Smickle, Riegel Paper Corp.; George Hunt, Scott Paper Co.; Philip Cerasoli, W. C. Hamilton & Sons; Bruce Schrier, Riegel Paper Corp., the four contestants in the 1955 E. J. Albert Award competition, May 26, 1955, Engineers Club, Philadelphia, Delaware Valley Section of TAPPI

Treasurer: D. C. Kane, Paper Makers Chemical Dept., Hercules Powder Co., Wilmington, Del.
Secretary: George K. Boger, Jr., Paper Products Mfg. Co., Swarthmore, Pa.
Executive Committee: Frank J. Lovegren, P. H. Glatfelter Co., Spring Grove, Pa.; Emil R. Padavic, Container Corp. of America, Manayunk, Pa.

At the May 26 meeting, which was held at the Engineers' Club in Philadelphia, four papers were presented in competition for the Albert Award. During the time the judges were preparing their final decision a question and answer period was held.

The four papers presented were judged as follows:

1. "Correction of Color Two-Sidedness at the Size Press," by Philip A. Cerasoli, W. C. Hamilton & Sons.
2. "Organoleptic Quality Control in a Speciality Paper Mill," by Bruce Schrier, Riegel Paper Corp.
3. "The Value of the Beta Gage Profiler to Determine Coating Distribution," by Walter R. Smickle, Riegel Paper Corp.
4. "Evaluation of Paper Mill Biocides," by George R. Hunt, Scott Paper Co.

The award presentation was made by E. J. Albert, and the papers will be published in another issue of *Tappi*.

GEORGE K. BOGER, JR., *Secretary*

Lake Erie

The following papers were presented at a meeting of the Lake Erie Section held on May 24, 1955.

Problems in the Production of Machine Coated Paperboard

Melvin Johnson

MY SUBJECT for this discussion is "Problems in the Production of Coated Paper Board." I have modified this to "Problems in the Production of Machine Coated Paper Board," and I would like to further modify this to a specific type of machine coating equipment, the Champion coater.

MELVIN JOHNSON, Container Corp. of America, Wabash, Ind.

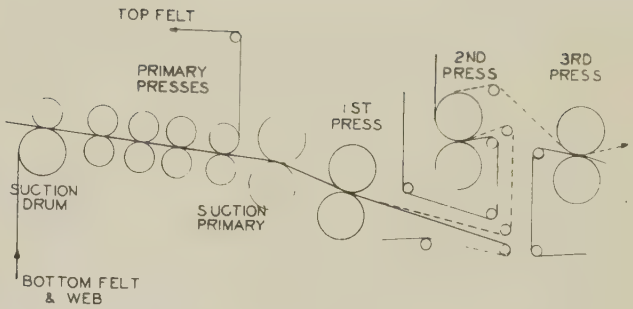

Fig. 1. No 1. machine, wet end

We have both air knife and brush coaters at Wabash for off the machine coating. This type coating operation produces coated paper board with fewer problems than the machine coaters for the following reasons: (1) a finished sheet, as smooth as white patent coated, is used as the body stock; (2) unsatisfactory material can be removed before coating; (3) coat weights are easily measured and controlled; (4) corrections can be made without an excess of machine down time because of the flexibility of the operation; and (5) the quality is closely controlled.

In addition to inspection at the paper machine, the sheet is further inspected at the coater, supercalender, and at the cutter. However, off the machine coating is more expensive as this is a complete and separate operation. The demand for off the machine white coated board has decreased considerably since the advent of machine coating. The machine coated sheet is constantly being improved and is now suitable for all types of printing. Only those white coated orders requiring the highest quality surface are manufactured on the off the machine coating equipment at the Wabash plant. These coaters, referred to as brush coaters, are primarily used for specialty coating and colors on both boxboard and tag stock.

Machine coated paper board is the result of the demand for a less expensive coated stock. Cost-wise it rates between white patent coated and brush coated, giving former brush coated customers a lower priced, good quality substitute and allowing white patent coated customers to improve printing quality at a reasonable cost increase.

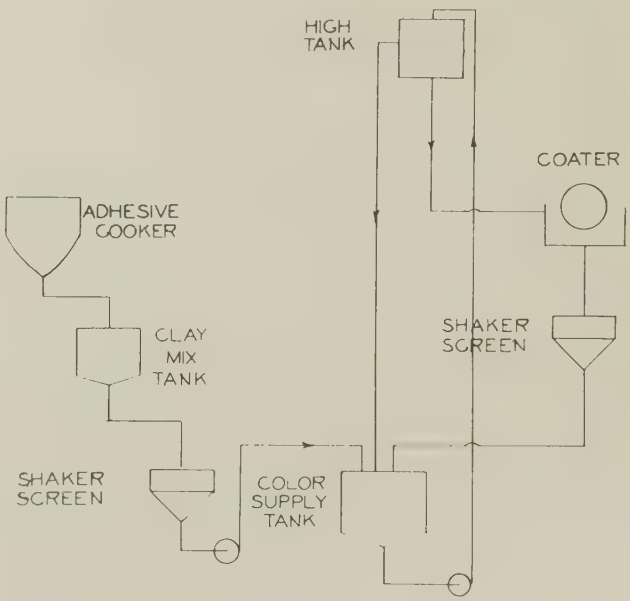

Fig. 2. Machine coating preparation system

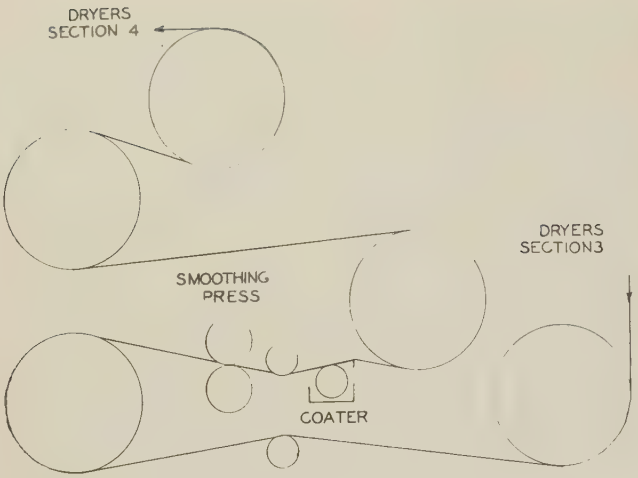

Fig. 3. Champion coater

In discussing the problems involved in machine coating paper board, I would like to start with the beater furnish.

The beater furnish is very important. In many cases mills have had to install additional refining equipment to hydrate the fibers and insure proper formation. The liner stocks must be selected and closely controlled to produce a tight bond between these stocks. Chemical adhesives tend to improve ply bonding. However, they also act as dispersing agents for the tetanium dioxide or clay in the liner stock—thus decreasing the final brightness. Stocks should be run as long as possible to facilitate water removal in the press section and produce the necessary bending properties. However, the freeness must be closely controlled as long stocks will cause liner pull or picking problems. The sizing of the body stock is important. The coating must penetrate into the sheet to form a good bond, while still remaining on the surface to produce the desired surface treatment.

Proper formation is necessary to enable the presses to be weighted to their fullest extent. Figure 1 shows the primary and press section of our no. 1 machine. Most high grade paper machines are equipped with several hard surfaced rolls that contact the paper web. These rolls smooth out the felt and wire marks and also remove a portion of the water from the sheet. The sheet entering the driers should be as dry as possible to prevent excessive shrinking. To help accomplish this, suction rolls are used as well as plain rolls.

The surface of the paper web when it arrives at the coater station is rough, full of small hills and valleys caused by the felts. The felts are chosen by their ability to remove water with as little resulting felt mark as possible. To make use of these fine felts, electric helper drives are required. These drive the primaries, presses, suction rolls, and in some cases

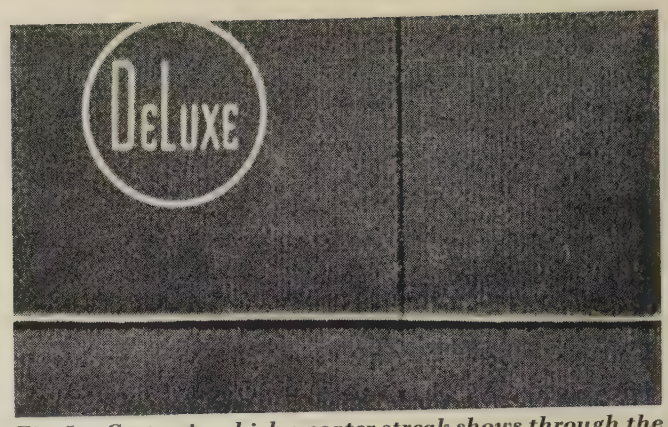

Fig. 5. Carton in which a coater streak shows through the printing ink

the cylinders. The life of these fine felts is much less than the coarser felts normally used for lower grade board production.

The application of coating to a sheet containing approximately 45% moisture creates additional drying problems. The coating tends to seal the top liner surface and this changes the normal drying process. More water must escape through the bottom surface. Since additional water was added at the coater station, the sheet tends to cockle and warp. Assuming proper stock preparation, this condition can be corrected by adjusting the tension on the draws. These draws are run as tightly as the sheet will permit. Driers that are out line of or out of round must be corrected or replaced.

Figure 2 is a drawing of the coating preparation equipment and the supply tanks. The adhesive, casein or soy protein, is cooked in a jacketed cooking tank. While the adhesive is being dissolved, the clay slip is prepared in the lower tank. Both tanks are equipped with high speed agitators. The dissolved adhesive is added to the clay slip. The coating is agitated for a short time, strained, and then pumped to the main supply tank. From here the coating is pumped to the high supply tank where a constant level is maintained by the use of an overflow pipe. This high tank helps to reduce foaming in the color pan. The coating flows by gravity to the coater color pan. The level in this pan is maintained by overflows from both the front and back sides. These overflows return to the main coating supply tanks.

Figure 3 is a line diagram of the Champion coater. It is a very simple coater consisting of an applicator roll which delivers an excess of coating to the paper web, and a doctor blade which removes approximately 50% of the coating and returns it to the color supply pan. The amount of coating remaining on the sheet is controlled by the coating viscosity, per cent of solids of the coating, and moisture content of the

Fig. 4. Split

(*Left*) Satisfactory sheet after coating has been applied. (*Right*) Pattern in sheet showing through coating.

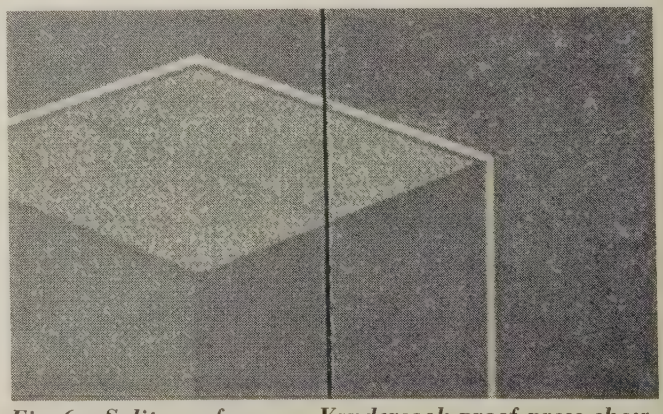

Fig. 6. Split proof run on Vandercook proof press showing:

(*Left*) Satisfactory sheet. (*Right*) Sheet with coating pick.

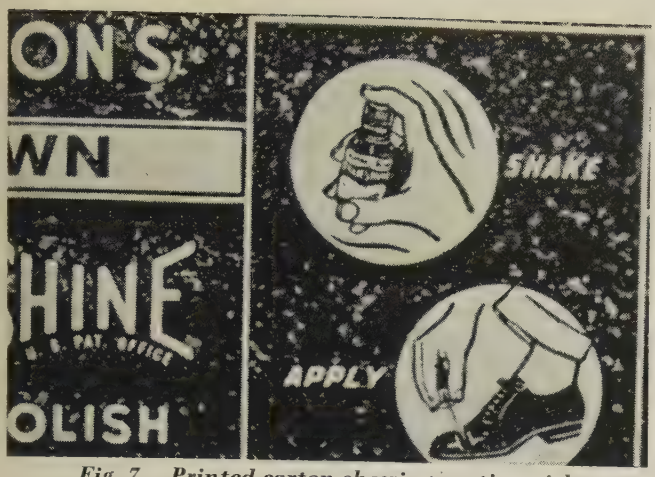

Fig. 7. Printed carton showing coating pick

paper web. One coater will usually apply a coat weight of 2 lb. per 1000 sq. ft. Two coaters will produce a finished board with a coat weight of 3 to 3.5 lb. per 1000 sq. ft. The coated surface contacts the second drier after the coater. It is sufficiently set up at this point so that picking does not occur. Coating does transfer to the driers during a break when the tension over the doctor blade is lost. This allows an excess of coating to remain on the paper web and this web coating adheres to the drier surface. Some driers are equipped with steel doctor blades to remove this coating, and the driers are scraped by hand each time the machine is washed up. At times, the coating forms small, hard particles on the drier surface, which tend to emboss the sheet with small pit marks, usually objectionable to the printer.

As stated previously, the surface of the paper web entering the coater is very coarse even when a fine felt is employed and the press rolls are correctly weighted. To remedy this condition, smoothing presses, consisting of a pair of chrome-plated, chilled iron rolls have been installed ahead of the coater. These have not been used very successfully ahead of the first coater, due to the operating problems involved in calendering a sheet containing 45 to 50% moisture. At the second coater they cause fewer problems and are very beneficial in smoothing the surface. The rolls are usually sweated by circulating cold water through the hollow core to prevent picking.

Figure 4 compares a satisfactory sheet with one in which the felt pattern shows through the coated surface.

The calendering operation is critical as the clay coated sheet tends to darken and mottle when calendered. Water finishing the coated sheet helps produce a glossy appearance. Some coatings are dissolved by the water box solution and pick off on the calender rolls causing streaks. The addition of insolubilizing materials will prevent this problem and increase the wet rub resistance.

This very generally covers the basic machine problems. We can now discuss specific problems.

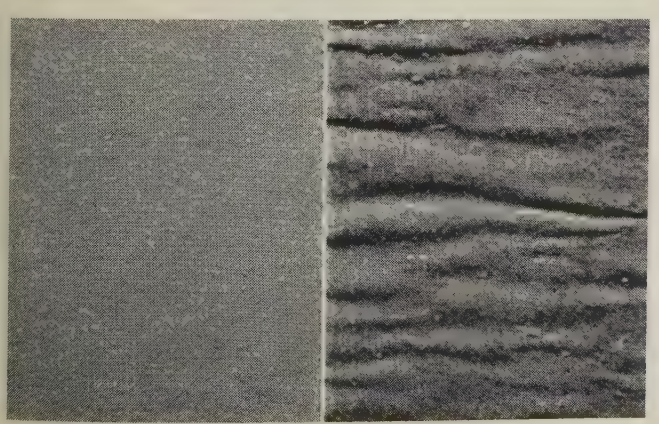

Fig. 8. Split proofs run on Vandercook proof press

(*Left*) Satisfactory sheet. (*Right*) Sheet showing liner pull.

COATING PROBLEMS

Coater Streaks

Figure 5 shows a coater streak. These streaks can be very small and sometimes are not apparent until the sheet is printed. They are caused by small particles of coating adhering to the coater doctor blade. These small particles remove almost all the coating instead of the normal 50%. This problem has been relieved, to a great extent, by the use of a rotating doctor blade rather than a stationary scraper. To remove these particles, the coater station is lowered and the blade is cleaned with a special wire brush.

Coating Pick

Figure 6 is a split proof. One side is satisfactory, the other shows evidence of coating pick. Figure 7 is the result of printing the questionable board on a printing press.

Coating pick can be caused by improperly prepared coating; insufficient adhesive in the coating slurry; non-uniform base stock, and other reasons, such as loose fibers or particles of dried coating being re-applied by the coater. To help eliminate this last cause, shaker screens are used on overflow return lines from the coaters to the supply tank and the fresh supply of coating is always strained. The Dennison wax pick test and pulling a proof print will indicate a loose coating condition. We use an ink with known tack to test all our machine coated board and, in addition, usually split proof test the sample with a board we know is satisfactory.

Liner Pull

In Fig. 8 you can see the results of proofing a questionable sample with one that is satisfactory. Liner pull is usually caused by improper selection of the liner stocks, by improper control of the hydration of these stocks, or by poor formation.

Coater Stop

Coater stops can be caused by either the coater applicator roll stopping, or a failure of the coating supply. Warning lights can be used to indicate these conditions.

This discussion has not covered all the problems involved in the production of machine coated paper board. However, I hope it has given you some idea of the variety of problems facing the paper manufacturer.

Factors in the Printing of Mineral Coated Paperboard

Harry C. Fisher

THE basis of my discussion of "Factors in the Printing of Mineral Coated Paperboard," is the complementary aspects of the coating on board and the printing of the coating.

Mineral coating is imposed on paperboard to improve the surface of the sheet in appearance and physical properties, and to improve its ability to receive printing inks, varnishes and other decorations. Qualities common to all satisfactory layers of mineral coating on board, however applied, are adequate coverage, opacity, brightness, color, flatness, evenness, and smoothness. Also the layer must have cohesive strength, be strongly attached to the paper surface, and be jointly foldable with it.

The effect on printing of thick versus thin layers of coating on the board is not decisive in the range of thicknesses commonly employed, although with very thin layers the underlying board surface may exercise some influence on the behavior of the printed ink.

HARRY C. FISHER, The Gardner Board & Carton Co., Middletown, Ohio.

The quality of printing obtainable on the mineral coating on a given coated board is influenced by the nature of that coating and the nature of the printing ink used. Similarly, the quality of printing required to be done on a coated board dictates the type of coating mixture to be used, its composition and, perhaps, its method of application to and finishing on the board—certainly if the best printed result is to be obtained. Thus, these aspects of the process of printing on the mineral coating complement each other. This is a handy tool with printed folding cartons made of coated board where the qualities of the coated board, printed and not printed, need be adjusted to each other to give the optimum result in printing process and printed result.

Three factors cooperate to produce a satisfactory quality of printing on mineral coated board. Their cooperation may be expressed by the equation

Coated board plus ink plus printing process = 100 = the satisfactory printed coated board

Expressed by symbols this reads

$$AB + I + P = 100 = \text{the printed product}$$

In the equation, P, the printing process, is less variable than the coated board or the ink (on a given printing press or in a kind of printing process); hence P may be omitted from our considerations or may be assigned a fairly constant value K, excepting as noted in no. 1 following. The rewritten equation is

$$AB + I + K = 100$$

Study of the equation in light of practical experience reveals that:

A. There is a minimum value assignable to each left hand term below which the term becomes valueless and the equation inoperative.

B. At or above the minimum, the deficiencies in one term, AB, may be compensated for by the plus values of the other term, I, (considering the third term, K, as constant in value). This means that moderate deficiencies in the quality of coated board surface in a certain respect may be remedied by using an ink of better than usual quality in the same respect. It also means that a completely unsatisfactory quality of coating on board cannot be printed satisfactorily, no matter how excellent an ink is used. It means, too, that the coating and ink must be selected to cooperate to produce the desired printed result, e.g., coating formulated to print flat must be printed with a "flat" ink.

Let us list and compare the complementary properties of mineral coatings on board, and printing inks, these latter being selected as oil and varnish vehicle letterpress inks. Clear varnishes printed over mineral coating will respond similarly. The mineral coatings discussed are those with proteinaceous adhesive, chiefly, and it is to be understood that the various modifying treatments sometimes employed in board coating are substantially excluded from consideration.

1. The ink must "work" satisfactorily on the printing press, in production. Of course, this is a basic requirement for ink printed onto any kind of board, coated or not coated, but the point is that an ink may be found capable of giving a desired printed result by proof press but which will not "work" satisfactorily in production.

A corollary is that the coated board must handle satisfactorily on the production printing press. The over-all characteristics of the coated board must be sufficiently high in quality that the layer of coating remains integral, flexible, and foldable with the fibrous sheet of board, and is not broken or stripped away, marred or scratched by the mechanical agencies and handling acting on the sheet as it passes through the printing presses. (The same requirements are necessary in the printed coated sheet as it is subjected to mechanical forces when being cut, scored, and creased in to the carton-blank, when the blank is folded and glued, and the folded carton is erected, filled and sealed, etc.)

Number 1 of this list of complimentary properties is an instance where constant K of the equation the printing process, may be readjusted with profit to relieve the effect of mechanical forces on the coated surface of board. However, such readjustment is likely to be small.

2. Both the wet and dried printed ink must adhere to the coated surface. The ink must be compounded to that end. The coating must be formulated of materials of such quality and in such proportions of them that the coated surface is rapidly and completely wetted by the printed film of ink, and that the ink film, after drying and "setting" does not separate or become separable from the coated surface.

3. The printed ink must "lay" evenly and uniformly in a thin adherent film in and on the coated surface. It must not "crawl, draw-up or ball-up" on the coated surface. Here, again, the coating must be made easily wettable by the ink.

In contrast, the printed effect should not be "washy."

4. The printed ink film must not be strongly absorbed by the coated surface, on the one hand, nor—preferably—lay completely on top of the coated surface, on the other hand. With a given kind of coating mixture, and considered aside from the absorptive quality of the minerals, this situation is controlled by varying the ratio and kind of adhesive substance to finely-divided minerals in the coating mixture. As the ratio of adhesive to minerals decreases, the absorptive power of the finely-divided minerals increases; as the ratio increases, the absorptive power of the minerals decreases. In a practical way, the ratio selected is a compromise between excessive and deficient absorptivity.

The quality of printing with gloss inks on coating is promoted by coating in which the ratio of adhesive to minerals is high; similarly, flat printing is promoted by a lower ratio. Coating, having the compromise ratio, just mentioned, often responds satisfactorily to both gloss and flat printing where the ink is compounded to complement the coating.

The hardness and abrasiveness of a coating layer are appreciably increased with high ratios of adhesive to minerals, and this may contribute to loss of quality of printing on the coating. Apparently, this coated surface does not deform easily to conform to the surface of the printing plate when under printing plate pressure. The increase in abrasiveness may be reflected in shorter plate life. The remedy would seem to reside in adjusting the formulation of the printing ink, insofar as possible, to permit use of a mineral coating having a lower adhesive to minerals ratio.

5. Printing ink must not be so strongly tacky that it picks the coating on the board; conversely, the internal cohesion of the layer of coating and the adhesion of the coating layer to the board's fibrous surface must be great enough to permit the ink to have practicable tackiness, as required by the use of the ink.

A compromise must be reached between the ratio of adhesive to minerals in the coating, and the tackiness and printed quality of the ink, as in (4) and (5). Here the wax pick test on coating is useful.

6. A finished coated surface of board should be substantially free of visible pattern—completely free, if possible—in order to improve the evenness and uniformity of printed ink film on the coated surface. To the extent that the printing ink can be used "soft" and has some flow properties, it can cooperate with the smooth coated surface to produce a smooth, even, patternless printed ink film on the coated surface.

7. Nothing must be present in or on the layer of coating, or its ingredients, having an undesirable effect on the characteristics of the printing ink used on the coated surface. Undesirable effects include uneven, too rapid or too slow drying of the ink film, decreasing its adhesion to the coated surface, etc.

8. Dust is undesirable on any coated surface to be printed;

its cumulative bad effect needs little comment. Dust is worse with offset than with letterpress printing.

9. Resistance to water and moisture are necessary properties for mineral coating on paperboard, particularly that to be converted into cartons and other containers. Even where much of the coated area is covered solidly and thus protected with printing ink, deficient resistance of the exposed coated areas to water and moisture provides a path for harmful water and moisture effects—they gaining entre at the exposed unprinted areas from cut edges or from the back of the board.

10. A coated surface, printed or not printed with ink, must be satisfactorily rub-resistant. The subject "rubbing" has many facets, including the effect on rubbing of most of the complementary properties listed above. What is the result of rubbing printed against unprinted coated surface, printed against printed coated surface, and unprinted against unprinted coated surface? What is the effect of temperature and humidity on rubbing? All these conditions may be present with two opposed carton surfaces.

Related to rubbing is the extent of the abrasiveness of mineral coating on board. Also, the coating must not be abrasive to printing plates and cutting knives, for example.

11. Cracking at the score line of ink film printed on coated board used for folding cartons must be prevented. This is a problem for the boardmaker and coater more than for the printer and ink; often the expert in the cutting and creasing of carton blanks can assist in overcoming the cracking, particularly in border line cases. Truly thick layers of coating crack more than thin layers.

12. Undesirable odors must be absent in printed coated board. The board, coating and ink each must be free of undesirable odor and they must not "react," directly or in the printed pile of coated sheets (or in the roll) to produce an odor.

An odor-producing "reaction" within the pile of printed sheets would seem to be unlikely. Yet, when one considers the confined atmospheric conditions prevailing within a large pile of sheets of freshly printed board, the possibility of fixing the confined odors into the board as the ink dries, of aerobic and anerobic reactions as the ink dries and sets, of the close contact of board surfaces in the heavy pile, of warmth in the pile, etc., the likelihood of "reaction" increases.

Actually, the possibility of generating odors is small, but it must be kept in mind, as with heavy glossy films of ink or varnish, or where a supplementary treatment or coating (not necessarily mineral) is placed on the back of the board.

The title originally suggested for my talk was "Experiences with Printing Coated Paperboard." I changed it to "Factors in the Printing of Coated Paperboard" as being more representative of my experience because I am not a printer acquainted in detail with the printing of coated board.

There is a stage in the evolution of a coated board and in the printing of it when the complementary aspects of coating and printed must be accommodated to each other. Once that has been done, and thereafter excepting for radical new printing requirements, and providing that the boardmaking, coating, and printing remain practically unchanged, the experiences in printing the coated board will be routine.

It is departure from the usual that produces printing difficulties and new experiences. I list a few experiences from memory (please do not request details!) with the added comment that they cannot be attributed to the coating only, in many instances.

1. A coated board calendar treated on its back with an antioxidant for packaging purposes. Enough antioxidant offset onto the coated side to prevent a red printing ink from drying for a couple of weeks. (It could have occurred with board not coated.)

2. Streaks of acidic solution splattered at random over the coated surface of board, and without visible evidence of their presence or source. The dark blue printed ink films showed decolorized streaks corresponding with the acid streaks.

3. A solid gloss ink printing over mineral coating on board, with occasional unprinted areas, was required to be subjected to severe rubbing with a water solution of detergent. Both ink and coating loosened from the board. The remedy was in the coating.

4. Coated boards which would not print specific inks flat or glossy enough. With standard coated boards the remedies lay in the inks.

5. Ink films on coated board which, after drying and setting, tended to be soft and could be pushed off by finger nail. The remedy—the ink.

6. Printing inks of various colors which tended to "crawl," "ball up," etc., on the coated surface. The remedy often lies with the inks—not that the inks are faulty always, but that they can be adjusted more easily than the coating formulation in many instances.

7. A light blue tint of ink which, in large solid areas, printed with "washy" appearance on the coated surface—stronger in shade in some areas than in others—as if the ink had been flowed over the coated surface. The remedy was in the ink. Many changes in coating failed to remedy the trouble.

8. Large separate areas of flat and of gloss printing were required on the same sheet of coated board. Here the tendency was for the flat areas to show patches tending to print glossy, and the glossy areas patches tending to print flat. The remedy lies in adjusting the adhesive-minerals ratio in the coating, and in adjusting the inks. This can be a delicate operation for if the adhesive ratio is lowered too far—to improve flat printing—the quality of gloss printing will suffer, and if the gloss ink is improved *per se*—it may become so tacky as to pick the coating.

9. Fine halftone printing—requiring every "dot" to be printed—needs an excellent flat smooth even coated printing surface. Departures from this quality of coated surfaces ruin the halftone printing.

Maine-New Hampshire

About 218 attended the Spring meeting of the Maine-New Hampshire Section of TAPPI, at North Conway, N. H. The meeting was under the chairmanship of A. E. Jones, Oxford Paper Co., also chairman of the section. The technical program was directed by R. J. Martin, Fraser Paper Ltd.

Following registration at Eastern Slope Inn the delegates were conducted through the Cascade Mill of the Brown Co. in Berlin, N. H. Here they saw the manufacture of paper towels, particularly on the machine named "Mister Nibroc," and were generously plied with samples.

During the afternoon, the technical program consisted of four papers on paper machine operation.

These papers were:

"Operating Problems on High Speed Tissue and Towel Machines," by C. M. Howell, University of Maine.
"Some Important Items in Building a Paper Machine Not Included in Contract Specifications," by S. M. Bratton, Pusey & Jones Corp.
"Drying Problems Encountered on Great Northern's No. 5 Newsprint Machine," by A. E. Levensailor (presented by J. A. McLean, Great Northern Paper Co.)
"Adjustments and Start-up Problems of a Suction Pick-up on a High Speed News Machine," by Edward Beachler, Beloit Iron Works.

During the technical session J. J. Thomas announced the slate of officers elected for the coming year. These were:

Chairman: A. E. Jones
Vice-Chairman: R. J. Martin
Secretary-Treasurer: H. E. Pratt
Executive Committee: J. F. Wright, re-elected; A. E. Bachmann, re-elected; Paul Goodloe, elected

Mr. Jones announced that the Fall meeting of the Section will be held on October 28–29 at the Lafayette Hotel in Portland.

The deadline for entries for the Worthen Brawn award was given as August 15.

At the evening banquet, L. F. Whittemore, president of the Brown Co., addressed the group, expressing the view "that the future progress of the industry will depend, to a great extent, on its technical personnel and that there is much to be done toward the attainment of complete cellulose utilization."

Following the dinner, a dance was held at the Inn.

On Saturday morning a panel discussion was directed by J. H. Heuer of the Great Northern Paper Co. Panel members who ably answered all questions on "Paper Machine Operation Problems" were: Mr. Bratton, Mr. Thomas, Prof. Howell, Mr. McLean, Mr. Starkweather, and Mr. Beachler.

In the afternoon golf tournaments were held under the supervision of Messrs. Kneeland and Mazeau. The prize winners were announced at an informal evening banquet.

COMMITTEES AND CHAIRMEN

General Chairman: Arthur E. Jones, Oxford Paper Co., Rumford, Me.

Technical Program Committee: Ronald J. Martin, Chairman, Fraser Paper, Ltd., Madawaska, Me.; John H. Heuer, Great Northern Paper Co., Millinocket, Me.; Andrew J. Chase, University of Maine, Orono, Me.

Local Arrangements Committee: Jack Fife Wright, Chairman, National Aniline Div., Boston, Mass.; Bartlett A. Taylor, James A. Taylor & Son, North Conway, N. H.; H. E. Pratt, Pejepscot Paper Div., Brunswick, Me.

Public Relations Committee: Edward N. Poor, Chairman, Hudson Pulp & Paper Corp., Augusta, Me.; Wadsworth L. Hinds, Keyes Fibre Co., Waterville, Me.; Arthur Sullivan Brown Co., Berlin, N. H.

Men's Golf Committee: John F. Kneeland, Chairman, Arnold, Hoffman & Co., Inc., Lewiston, Me.; John R. Mazeau, Appleton Woolen Mills, Portsmouth, N. H.

Women's Entertainment Committee: Mrs. Arthur E. Jones, Rumford, Me.; Mrs. R. J. Martin, Madawaska, Me.; Mrs. J. J. Thomas, Westbrook, Me.; Mrs. Bartlett A. Taylor, North Conway, N. H.

Nominating Committee: Clifford Patch, Chairman, Eastern Corp., Bangor, Me.; Joseph J. Thomas, S. D. Warren Co., Westbrook, Me.; Jack Fife Wright, National Aniline Div., Boston, Mass.

E. N. POOR

Some Problems of High Speed Tissue Paper Machines

C. M. Howell

As I understand it, the general subject of this meeting is "Paper Machine Operating Difficulties at High Speeds." Since my operating experience has been limited to machines making toilet tissue or towels, I shall limit my part of the discussion to these machines, placing most of my emphasis upon the tissue machines, since they are now the fastest paper machines in the world, running as high as 2800 f.p.m. in actual production.

The development of the high-speed tissue machine of today, divides logically into three broad general steps or periods. These are as follows:

1. Up to 1934 most toilet tissue was made on fourdriniers essentially like newsprint fourdriniers, only with shorter wires. Maximum wire speed at Scott Paper Co. was about 1000 ft., the fastest tissue machines in the world at that time.

2. In 1934, there was a revolutionary change in the method of forming tissue when Kimberly Clark developed the pressure inlet and used the head of water behind the inlet to force the water of formation through the wire very quickly. Maximum wire speed at Scott Paper was approximately 1600 ft. and Kimberly Clark ran faster than this on crepe wadding.

C. A. HOWELL, University of Maine, Orono, Me.

3. About 1946 or 1947, the Scott Paper Co. started a machine at Fort Edwards, N. Y., still using the pressure inlet, but adding to it the use of a specially constructed suction breast roll. By adding the vacuum in the suction roll box to the pressure of water on the inlet, a much greater difference of

Head table at the Maine-New Hampshire Section dinner: G. A. Day, Brown Co.; E. M. Hopkins; L. F. Whittemore, Brown Co.; A. E. Jones, Oxford Paper Co.; R. G. Macdonald, TAPPI; R. J. Martin, Fraser Paper Ltd.; Mrs. Martin; and J. H. Heuer, Great Northern Paper Co.

pressure was secured, together with a longer formation area. Maximum speed thus far is 2800 ft., but the limit in speed is no longer formation.

I think it will be interesting in this paper to discuss the development of the high-speed toilet paper machine under these headings. I will attempt to name and discuss the most important difficulties that have been experienced with each of these three types of machines. I must point out that my own actual experience was limited to the first two types. My actual first-hand knowledge of the third type is limited to participation in discussions of this type of machine during its preliminary stages and to observation of an experimental run on a small experimental forming section that was built and tried out at high speed before the actual machine was built and installed at Fort Edwards. My observations about the difficulties experienced with this machine and others built since then are based for the most part upon what I have been told by some of my old friends who participated in the start-up and subsequent operation of the machine at Fort Edwards and the first large machine of this type installed at the parent plant in Chester, Pa.

Now let's discuss the first type of machine.

NEWSPRINT TYPE OF FOURDRINIER

On this machine, we had a beautifully designed and built VandeCarr type of inlet that discharged the stock and water on the wire very smoothly. The headboxes and approach systems were designed by our own engineers and were a good job. Most of the trouble developed on the fourdrinier itself. The newsprint fourdrinier with the use of a forming board and deflectors has just about the right water removing capacity for a newsprint sheet containing 85% groundwood. This is demonstrated by the fact that basically, the latest fourdriniers on which newsprint is being formed at speeds in excess of 2000 f.p.m. are the same in principle as the ones built back in 1922 and 1923 when Scott started to develop its tissue machines, based upon the newsprint type. For tissue however, weighing only about $10^1/_2$ lb. on the wire and containing a maximum of 30% groundwood in our cheapest grade of toilet paper, and only 5 or 10% in Scottissue, the newsprint type of fourdrinier, even with a 55-ft. wire, had entirely too much water removing ability. So, on this fourdrinier, as many as four forming boards were used to reduce water re-

moval. Also, the number of table rolls used had to be greatly reduced, and groundwood as slow as 20 ml. in freeness had to be used, all to hold the water in the sheet as long as possible.

In addition to the excessive water removal of this type of fourdrinier for tissue, the solid table rolls caused trouble. A

J. A. McLean, Great Northern Paper Co.; A. E. Jones, Oxford Paper Co.; R. J. Martin, Fraser Paper Ltd.; C. M. Howell, University of Maine; E. D. Beachler, Beloit Iron Works; and S. W. Bratton, Pusey & Jones Corp.

10½-lb. sheet is easily disturbed upon the wire by the water thrown out by the solid table roll and by the water that is carried along under the wire being pushed up through the wire and the sheet at the nip of the solid table roll. The best designed deflectors we could develop, and we tried many, would not eliminate all of these difficulties.

For these reasons, the maximum speed we could run these machines was approximately 1000 ft. on the wire, or a little better, and the formation of the sheet was not satisfactory. It was always too flaky and wild, or had too many pinholes. It was also somewhat streaky. The standards set up by the quality department were very strict and kept the quality of the toilet paper we were then manufacturing considerably better than our competition at that time, but only at the limited top speed of 1000 ft. and with considerable loss in rejections.

These machines also had a plain bottom couch roll and the top couch roll inside the top felt was couched toward the headbox. It acted as a press and squeezed considerable water from the sheet at this point. This type of pickup arrangement, however, is inefficient in picking the sheet from the wire. We, therefore, had considerable trouble in picking the sheet from the wire. We, therefore, had considerable trouble at this point, particularly with new top felts. It sometimes took 8 or more hours to get the top felt sufficiently broken in to make good paper. Moreover, it was necessary to start the new top felts on new wires to minimize the pickup difficulties. This meant the sacrifice of some wire life or top felt life in order to synchronize new wires with new top felts, because while the average life of wires was about 2 weeks and top felts about 4 weeks, the possible life of individual felts and wires varied over a rather wide range. This also caused more shutdown time over the year, because we lost 8 to 12 hr. production time every time we had a complete clothing change.

The press section of this machine had only one suction press, the second press being a plain brass covered bottom press with a 30 to 35 P&J density rubber covered top press. This arrangement dried a sheet to 70 to 68% moisture content. Since we did not, at this time, dry the sheet with steam heat, we had to crepe this relatively wet sheet. The main softening effect in toilet paper is secured by the effect of creping, plus the breaking down and smoothing effect of calenders. The softening effect increases rapidly with increased dryness of the sheet at the point of creping. There was only a small amount of softening effect at the high moisture content we creped on these machines.

Moreover, at such high moisture content, the crepe pulls out easily. This fact resulted in great difficulty with wrinkles in the paper developing between the creping doctor and the first bottom drier.

In addition to the above, a light weight tissue sheet at such high moisture content is very tender, and so we had many breaks since almost any defect in the sheet could cause the creping doctor to pick a hole in the sheet and so cause a break.

In the press section itself, we had difficulty in keeping felts clean, soft, and open. The top felts, when new, and with too wet a sheet at the creping doctor bothered with picking up. The top felt gave reasonably good performance for 2 to 3 weeks in its middle life. As it got older, it became harder, more dense, and the quality of the paper started to decrease.

About 1930, the plain second press was replaced with a suction press. This resulted in an increased dryness of 2 or 3% at the creping doctor which gave us better quality paper and much less breaks. The felts were kept more open and softer throughout their life. They also lived longer on the machine.

There was no particular difficulty in the after driers on these machines. All rolls were equipped with generous size antifriction bearings, and the drier bearings were also equipped with a circulating oil system. With a periodical inspection of these bearings for roughness and efficient operation of the oil circulating system, our mechanical losses in the driers were very small.

The machines were equipped with Pope reels which were quite adequate at the speed we were running.

We had eliminated rewinders by installing a very high speed disk knife slitter which cut the paper into two jumbo rolls on the reel. Of course, this would not have been practical if we did not finish all our own paper. This move cut our machine crews down from five to three men, and the three men had easier work than the five had had with the rewinders.

PRESSURE INLET MACHINE

In 1934, I was engineering manager of Scott Paper Co. and I had the responsibility of installing a complete new paper machine with its supporting equipment. The management for the first time in the history of Scott Paper Co. gave the engineering department ample time to install the machine so that we were able to thoroughly investigate and study everything that had been done in other paper mills, to determine if we could radically improve this machine. This was the first time we had Beloit build our machine, although they had rebuilt some parts of the old machines, and they brought in a fresh viewpoint. This was particularly true of Earl Berry, who was then vice-president in charge of engineering, at Beloit, and, to me, the best and most creative paper machine engineer with whom I have ever come in contact.

Many new features were incorporated in this machine including a 12-ft. Yankee drier as a creping drier. Also, through Mr. Berry, we learned of a new type of inlet developed by Kimberly Clark and built by Valley Iron Works, and installed at Niagara Falls. We secured permission to visit this mill and were tremendously impressed with the fine job it was doing with the formation of Kleenex. We persuaded our management to permit us to install this inlet on the new machine. Valley Iron Works built this first inlet, so we could operate it as a standard Voith inlet, or by running the upper inlet out over the wire, it could be operated as a pressure inlet. This was done, and the results on the new machine were so good that all the five machines were equipped with this inlet and with Yankee driers.

The pressure inlet type of formation is just the reverse in its problem from the newsprint type of fourdrinier. With the pressure inlet, advantage is taken of the small resistance to

water removal of tissue paper and nearly all the water of formation is removed in a space of 3 or 4 in. by the pressure of the water behind the inlet forcing the water through the wire. This greatly changed the down wire problem. Because so much of the water was removed at the inlet, the solid table rolls could be replaced by dandy rolls without the wire cover. These rolls without the wire cover remove a very small amount of water compared to solid rolls. Their open construction practically eliminated any tendency to disturb the formation of the tissue, which could be almost perfectly formed at the inlet. These machines gave us both beautiful formation and a much improved softness of the paper. Besides this, we were able to form the sheet at much higher speeds. The speed went from 1000 to 1200 very quickly and to 1400 within a couple of years. These machines ultimately were able to run up to 1600 ft. Finally, however, the limit was reached and it was due to an inherent feature of this type of machine. Both Kimberly Clark and Scott Paper soon found out that the head on these machines had to be carried at the theoretical head. Therefore, the amount of pressure that could be used to force water through the wire was limited to the theoretical head for the speed at which the machine was running. It was this limitation of the pressure inlet that caused Scott engineers to finally go to the suction breast roll, so that vacuum could be added to the pressure on top of the wire and so force out very much more water.

This type of formation introduced a new characteristic to the sheet. To a certain extent, the wire running under the pond of water in the inlet has the same effect as the wire on a cylinder machine has upon the sheet in dragging the fibers already attached to the wire through the water. In other words, the fibers were aligned lengthwise of the sheet to a considerable degree and so the new sheet was considerably stronger in the machine direction than in the cross direction. On the pressure inlet type of formation, I personally believe the degree of alignment of fiber a strong asset in quality.

A creped sheet is always stiffer in the cross direction of the paper than in the machine direction, due I believe to the stiffening effect of the fine rolls of crepe which act somewhat like the corrugations in corrugated steel roofing. The greater weakness in the cross direction tends to make the sheet less stiff in the cross direction, since, generally speaking, softness varies inversely as the strength of the paper and the overall result was a softer feeling sheet of tissue.

The main difficulties experienced on the fourdrinier of the new type of machine were with the wires. We had to change from the standard weave brass wires we were using on the old machine to a bronze wire with a twill or long crimp weave, because the great pressure put on the wire at the inlet necessitated a much stronger wire. For the same reason, the sewed seam was not strong or durable enough and the wire manufacturers fortunately came along with a welded seam wire, which solved this problem. For quite some time, some of the welded seam wires were imperfect and marked the sheet badly. Quite a few of these had to be removed and replaced. Eventually, the wire manufacturers overcame their difficulties, and wire seam trouble was eliminated.

Another difficulty that developed with the new inlet was caused by the collection of air under the ceiling of the inlet. An air pocket was formed and permitted stock, pitch, and slime to build up on the ceiling of the inlet. After the machine had been operating a few hours, lumps of this collection began to break loose from the ceiling of the inlet and ran out on the wire. For a time, it looked like a hopeless situation. However, we came up with a simple solution. A raised section was built on the bottom of the inlet behind the perforated roll, thereby increasing the velocity of the water sufficiently, so that the top of the inlet was swept clean. This eliminated this particular difficulty and all subsequent pressure inlets have been built with this "hump" as we labeled it.

The problem of picking up the sheet from the wire was eliminated almost entirely by replacing the plain bottom couch with a bottom couch with rectangular grooves in them, as on a Harper couch and the top couch was couched towards the dry end. With this arrangement, no water was removed by the couch rolls, but it was a very much improved pickup arrangement.

The press section included two suction presses with ample vacuum pump capacity, so that little difficulty was experienced with these machines in the press section.

The Yankee drier enabled us to crepe at 50 to 55% dry on toilet paper. This greatly improved the softness of the sheet and practically eliminated the wrinkle trouble as well as wet-end breaks. Thin steel doctors were used for creping, instead of thick bronze, such as had been used on the older machines. These doctors gave a more uniform, finer crepe and lasted much longer without filing or changing. One to two doctor changes in 24 hr. was considered normal. About 5 min. time was lost in changing one doctor. One trouble that developed with the Yankee driers was in keeping the drier surface clean and even. Eventually, it developed that these driers had to be reground in from 1 to 3 years. Beloit Iron Works loaned us a portable grinder that could grind a drier in about 3 days.

At the speed we were able to operate these machines, no particular difficulties developed in the drier section. We did have to keep a close watch on the tightening arrangement on the chain drive Beloit had installed on these driers. The chains lengthened with wear and the stretch had to be adjusted. Aside from this, no trouble was experienced.

In my opinion, at the speed these machines could operate, they were unusually efficient. At the time I left Scott Paper Co., they were operating about 1400 f.p.m., and I have seen a machine operate 72 hr. without a single minute's loss of time or rejection of any kind. In other words, perfect operation for 3-day period. They were limited in top speed by formation, however, and this was eventually overcome by the development of the suction breast roll.

SUCTION BREAST ROLL MACHINE

The idea of using a suction breast roll is not new. I visited a mill in Wisconsin sometime before the war, I think around 1935, where the superintendent had tried a suction couch roll as a breast roll. It worked reasonably well, but on the heavy sheet he was making, it shadow marked the sheet too badly, and so had to be discarded. The idea that Ostretag and Boylan, the engineers Scott assigned to develop a better tissue machine, came up with after a full year of study, investigation, thinking, and discussing what might be done to make better tissue at high speed, was essentially the idea of using a suction breast roll with a modified type of dandy roll construction. This roll did not mark the sheet. By its use, the machine at Fort Edwards has been able to run 2800 f.p.m. and the large machine at Chester 2500 f.p.m. While I have not seen these machines operate, I have pretty reliable information that insofar as formation alone is concerned, they could operate much faster.

At the higher speeds these machines operate, some of the problems experienced to a relatively small degree on the other machines, became much more serious.

1. The machine directional strength problem became very much greater. This is to be expected since with the suction breast roll all the formation is done under the inlet.

2. The pickup problem became very much more serious. It is my understanding that they have had to build a special very open type of bottom couch in order to permit the wire to give up the sheet more easily.

3. The difficulty of keeping the Yankee drier surfaces in good condition became much greater at the higher speeds. They have to be ground so often that Scott now owns one or more portable grinders of its own, and grinds the Yankees very frequently.

4. The reels of paper build up so quickly, it became neces-

sary to give the crew some help to secure more rapid turnovers. I have been told that completely cored-up reel shafts run down from overhead and the changeover is made automatically.

5. They had to put on a fourth hand to transport the jumbo rolls on the dolley trucks they use for this purpose. Having seen the automatic conveying equipment in use at East Millinocket by Great Northern on their new paper machine, I think Scott engineers could well profit by a study of this installation. Certainly, transporting jumbo rolls on dolley trucks by hand labor is, or now should be, obsolete on high-speed machines.

6. At the higher speeds, they needed more drying capacity in the Yankees. This has been secured by designing a specially built, high pressure Yankee and by the use of very high velocity air jets, blowing against the surface of the paper in a direction opposite to which the drier is turning.

7. It is my personal opinion, based upon what I have seen happen when a top felt tore off the machine at 1400 f.p.m. and occasionally wrap the pressure roll, that the problem of making sure this does not happen at 2500 f.p.m. must be a very serious one. No doubt the present Scott organization is very conscious of this and has taken steps to minimize the danger.

I have only touched a few high spots in this paper, and even so it is too long. I would like to say, in closing, that one of the biggest problems in speeding up new type paper machines of any kind, is always the problem of getting the operating crews educated to believe in the high speeds being possible and to learn how to operate them efficiently. This doesn't come overnight, as you all well know. I cannot help wondering about the tension a machine tender must be under operating a top felt machine at 2500 f.p.m. I have sat and talked to machine tenders about this when they were running 1400 ft. It really must be terrific at 2500 ft. For you see, if he loses a top felt, he also nearly always loses the wire and bottom felt as well. It's a tremendous responsibility, and I must say that in my experience I do not believe the top management always realizes just how great it is. They walk through a mill and see a machine running smoothly at high speed—no red lights for rejections on the drier hood, and perhaps the machine tender may be sitting down for a few minutes. Some of them think, as I have heard them say, "Pretty soft job the machine tender has. Why do we pay him so much money?"

I did not quite go along with one of our paper mill managers when he used to say, "I like to see a machine tender reading the paper, because that's when the machine is really making paper," but there is a lot to that point of view. My hat is off to a machine tender operating a high-speed paper machine, because to be a really good one, he must be a very able man.

Some Important Items in Building a Paper Machine Not Included in Contract Specifications

S. M. Bratton

Upon being advised by your program chairman, Mr. Martin, that the general theme of this meeting would be "Paper Machine Operating Problems," it immediately brought to mind that this was quite a large subject which could be discussed and commented on for a long period. So, after giving the matter some thought, a more appropriate title might be "Some Important Items in Building a Paper Machine Not Included in Contract Specifications."

The main subjects discussed when drawing up a contract and outlining specifications include such items as the width and length of wire; number of presses and driers; steam pressures to be used; number of calender stacks; whether there are driers between calender stacks; type of reel; and slitter-winder. Should it be a mechanical drive; this is discussed quite extensively. But since most new machines today are furnished with electric drives, this discussion is held with the manufacturers of electrical equipment and, occasionally, a consultation takes place with the machine builder regarding location of drives and powers required.

We refer at this time to the smaller items between the headbox and winder that play a very important part in the successful operation of the paper machine. These could be referred to as the "knack and tact" of the machine builder during the design and construction of a machine.

This reminds one of the story of the faithful butler who had been in the employ of a family for a good many years who was now busily occupied instructing one who had very little experience in the art of being a good butler.

During the instruction period, the old butler would refer to little things he did as "here you use a little knack" and "there you use a little tact." This kept up for a quite while and the new butler was becoming quite confused—what was the difference between knack and tact? So he says to the older butler "I just don't understand the difference between the two. You say 'here you use a little nack' and 'there you use a little tact.' Just what is the difference?" The older butler replied. "Well, when you do something and add a few extra touches, making it more pleasant and comfortable for the folks, that is knack. But should you, by mistake, go into the bathroom and the lady is taking a bath—if you say 'excuse me, sir'; that, my dear fellow, is tact."

The references following will be mostly the knack of the machine builder and not much of the tact since it will be impossible to cover both subjects at this time.

Let us begin with the headbox. Headboxes today are either the pressure type or open type, depending upon the kind of paper and speeds at which the machine will be operated. However, when speeds of 1500 f.p.m. and higher are anticipated, it is almost mandatory to use the pressure type of headbox in order to get the proper delivery of speed of stock on the wire. The gravity type of box for 2000 ft. or more would be a construction problem requiring excessive head room as well as stock in suspension. This is not very desirable and, often, the space is not available.

The selection of material for headbox construction must be of a noncorrosive type, and is usually of solid stainless steel, reinforced or with stainless clad plate. Since the smooth surface is very important, the particular type of stainless chosen must be able to stand the pH of the stock. Some types of stainless steel pit very easily, resulting in slime collection and eventually breaking down the paper.

It is seldom today that a headbox is constructed of wood. When it is, careful consideration must be given to the selection of cypress. Some types of cypress splinter easily, raising parts of the wood fiber and thereby collecting paper stock. This stock eventually forms a lump, breaks loose, and goes through the machine causing breaks which, as we all know, is a condition the papermaker wants to avoid. Not only does this result in a lot of extra work for the papermaker but it causes him to lose production, and the papermaker's pride is how much production and how few breaks in a day.

In selecting cypress for headboxes, the heart of the cypress tree should be specified. This part of the tree is of a much closer grain and will polish up very nicely and the wood fibers will not separate and catch lumps.

When specifying cypress for headboxes, stuff chests, or other tank work, it would be well to consult with someone who specializes in furnishing cypress.

It is considered necessary to have distributor rolls in headboxes to assist in breaking up currents that form from various types of entrances to the headbox. Usually, these rolls are made of noncorrosive metal tubes or plates with the holes very closely spaced, about an inch or inch and a quarter in diameter. When made of tubes, each hole must be drilled. The edges of holes are cleaned off both outside and inside

S. M. Bratton, Pusey & Jones Corp., Wilmington, Del.

which is a very laborious job, somewhat simplified with rolls 12 inches or more in diameter. These rolls are punched and the holes cleaned while the rolls are in flat plate-form, after which they are rolled and welded or brazed and all sharp spots are removed.

The rolls are driven for the main purpose of reversing the flow in order to keep them clean. There are various opinions regarding the direction and driving speed of these rolls and, for this reason, the machinery builder usually makes the speeds variable as well as reversible, placing the problem of speed and direction in the machine tender's hands.

Adjustment of the upper and lower lips is an important item. It is commonly known that their position with relation to each other, as well as the lower lip position with the centerline of the breast roll, has a direct effect on the distribution of stock on the wire. Changes in temperature and consistency will effect this flow, therefore, whenever possible both upper and lower lips should have machine direction adjustment.

The breast roll should be of sufficient diameter and strength to take the load with as little sag as possible. Normally, a little crown is put in breast rolls just to avoid them being hollow and to keep the wire straight. A sagging or hollow breast roll will cause the wire to ridge up in the middle.

An item usually thoroughly discussed when drawing up contract specifications is the type of fourdrinier—whether removable, nonremovable, rapi-drape, shaking or with raising and lowering of one end to have a pitch in the wire.

We are in favor of the rapi-drape type of fourdrinier for the specific reason that it is unnecessary to disconnect shake springs, suction box connections, shower connections and interfere in any way with the alignment or position of the fourdrinier. Also, we are of the opinion that this type of wire changing is quicker than any we have observed. However, it would be rather difficult to determine the exact time involved in changing wires since, as a rule, other work is done on the machine during the same period and, often, the resultant delays are charged to the time for changing wire.

In designing a fourdrinier part, it is essential that the rolls and parts be so arranged that there will be enough clearance for the new wire to be put over parts inside the wire and, at the same time, have sufficient take-up to run the wires at proper tension.

The length of fourdrinier wire should not be determined until proper forming space, number and size of suction boxes, and diameter of breast and suction rolls have been obtained. Only then will the wire on the return from the suction to the breast roll over the return wire rolls be such as to give a good arrangement and sufficient angle on the guide roll for guiding the wire. Neither this point nor the proper sizes of saveall boxes has been given sufficient consideration in the past. After this has been satisfactorily determined, the length of wire should be established.

Contrary to general thinking, it is just as simple for the wire manufacturer to make the wire in odd feet and inches as it is in even feet. In times past, very poor arrangements have resulted in the fourdrinier table due to someone specifying the length of wire to be an even 100, 120, or some other even number of feet.

It is not a fair comparison between machines to consider the wire length only. One may have more suction boxes or larger rolls than the other or perhaps the space is not being as economically used as it could be. Two machines have been seen in the same mill—one machine had a wire 20-ft. longer than the other and yet only a few more feet of forming space.

It has been found advantageous to use flat top deflectors between the table rolls, especially between those next to the breast roll. This enables the water to be retained in the wire, allowing it to be removed at the table roll instead of draining through, hitting down on the table roll, then going up through the wire again. These wide-type deflectors have shown an improvement in both formation and wire life. Therefore, careful study should be made, and since the deflectors are an item that can be installed a few at a time, it can be determined through trial and error how many deflectors of this type will give the best results.

A suction couch roll is a piece of equipment that requires very accurate and careful construction. In addition to the mammoth problem of mounting the antifriction bearings properly with the suction box, some rolls have suction boxes with two compartments; therefore, require two outlets to go through the journals and down the suction connections to the proper controls.

A suction couch roll 44 in. in diameter, 196-in. drilled face, has 82,339 holes, each of which is countersunk on the outside and cleaned up free from burrs on the inside. Should one or more of these holes fail to be cleaned and the burr protrude, the sealing in the suction box will be scored and it will then be necessary to remove the box and repair or renew the sealing strips.

These sealing strips must be very accurately set to match the curve of the inside bore of the suction couch roll shell and must be straight across, or else it will be difficult to get necessary vacuum to obtain satisfactory results.

A suction press roll is sometimes used as a plain metal roll and sometimes the face is covered with rubber. A 34 in. diameter suction press roll, 196-in. face, will have 156,801 holes. These holes are first drilled in the metal. The rubber cover is then put on, the shell is set up again, and the holes are drilled in the rubber. These holes are slightly smaller than those drilled in the metal and particular care should be taken not to touch the metal with the drill. If this should happen, too much heat at that point may result and start the rubber to leave the metal shell. Heretofore, it has been thought that the drill touching the metal might be the cause of some rubber covers becoming loose; however, it is rather difficult to get sufficient proof to make a positive statement.

On some high-speed machines being built today, an arrangement is installed which picks up the paper from the fourdrinier by way of suction to a pickup felt and transfers it to other felts and press rolls through to the driers. Of particular importance is the proper location of the suction box picking up the paper off the wire. Also, the run of felt to the transfer press must be at the proper angle in addition to the lead-off from this press. The felt is then led upward to the necessary stretchers and guides through a conditioning system which can be either the shoe type or wringer roll type of felt conditioner. In either case, a guard must be installed to keep the felt from throwing water over on the fourdrinier wire. In the event the wringer roll type is employed, the same guard is continued under and becomes a saveall which follows very closely to the felt in order to catch all water possible that may be discharged from the suction roll. Pans are usually installed between frames to prevent any drip from the upper felt at the stretcher part from coming down onto the sheet of paper as it goes through the after presses.

Size presses or presses installed either at the wet end of the driers or in an intermediate section usually have specified the type of materials for covering these press rolls. Sometimes, there is a disagreement as to which type of roll should be on top so it is common practice to make these rolls interchangeable between top and bottom in order that the operators can get whatever finish they desire on the top and bottom of the sheet. It is important that the lead of paper into these presses be thoroughly discussed with and approved by the papermakers. Provision should also be made so that this lead can be changed with very little trouble.

It is sometimes found the sizing material on size presses is so slippery that the top roll will not drive properly. In this case, it is necessary to put a drive on this top roll; also, top and bottom rolls should be made interchangeable.

Consideration is now being given to installation of a hot press at the beginning of the driers having approximately six driers ahead of the hot press to warm up the sheet, reduce the

viscosity of the water and get better water removal. This has been found to be very beneficial. On slow speed machines, plain presses can be used, but at higher speeds, the suction press is preferable. It has been determined from actual operation that approximately 5 to 6% of water is removed at this point. However, up to this time, it has not been deemed advisable to install hot presses on lightweight paper machines since the gain in water removal does not warrant the cost.

It is usual to establish the height of the driers above the machine room floor at such a point that should a paper drier become wrapped with paper, the operator will be at about the right level for getting the most power in his arms for cutting the paper with spears.

The location of the felt roll between driers is carefully considered so as to pass the paper over from one bottom drier to another should big wads be passed to the end of the drier section. The last felt roll at the end of a section usually is lower so that the bulk of the broke will go right into the basement without extra maneuvering. On some machines, the first felt roll of a section in the lower driers is underneath the drier so that in case of a break in the paper as it comes down from the upper drier, it will go on into the basement and not through the next section of driers. This arrangement of felt rolls is usually discussed with the operating crews to get their approval of these locations. Sometimes, they prefer the rolls being placed up into the higher positions.

The location of felt driers is another consideration; particularly, the Feeney driers which are sometimes called intervening felt driers wherein the felt comes off the paper down around the felt drier and back onto the paper again to the next succeeding drier. Particular care is exercised in locating these Feeney driers. In most cases, they are not required in the last sections, particularly on machines that have a large number of driers.

Now that machines are being operated much faster, the problem of the type of gearing and lubrication needs a lot of thought as the higher the speed of the pitch line of gears, the more accuracy is required, both in cutting and center distances. Years ago, the old type of gears used teeth cast in the foundry and these were considered sufficient. As speeds increased, the gears were machine cut, still retaining the freeness of the original gears mostly due to using the sleeve bearings which wore and sometimes would allow the gears to come in closer mesh than desired. However, they were run and some of them are still running today at very high speeds but they can be heard from long distances. Some of this noise is being eliminated by putting in a plastic tooth gear which does not correct the cause of the noise but somewhat deadens the sound since this gear is of a softer material. It appears to the operator and others that the condition has been corrected; however, such is not the case—the noise has just been reduced.

Steam joints are constantly being studied for any new designs that can be incorporated with particular emphasis placed on reducing the power and maintenance. Up to about 20 years ago, it was seldom that steam in driers was more than 25 lb. But now that they are getting up to 125 and even 150 lb., the steam joints have become a real consideration. And the higher the steam pressure, the more power it takes to drive the steam joints alone. If we continued to use the same joints we had 25 years ago, it would take considerably more power to run the steam joints than the driers. Just by changing the type of steam joints on some machines, higher pressures have been used. Also, driers have been added for the same input power by adopting the new type of steam joint.

The water removal system inside of the driers must be kept in perfect condition at all times. A drier half full of water will require as much power as several driers that are being run with proper drainage. Also, a drier with water cascading on the sides makes an unbalanced condition causing undue strain on the drier gears. Should these gears be of the older type with extra allowance of clearance and backlash, there will be excessive noise which is not only annoying but creates the possibility of a shutdown for changing gears which may have become overloaded and fractured.

Another point of open gears versus closed gears for speeds particularly 1000 ft. and above is that gears with these pitch line speeds must have lubrication. The lubricant that is thick enough to stick to the gears increases the power requirement, whereas a lubricant that will not increase the power is of such viscosity that it will throw off without giving proper lubrication. And since the gears are open, the oil goes all over the machine room floor. Therefore, it is almost impractical to lubricate open gears with any other than a tacky material.

Due to temperature changes in the dry part of a machine, proper allowances must be made for expansion and contraction at various points, particularly between the driving and tending side bearings of the driers. Should these bearing houses become stuck, there can be sufficient overload from thrust to destroy the bearings.

Careful study should be given the calenders to assure proper size rolls, types of housings, and clearances in the slides. Since it is absolutely necessary that the rolls be in perfect alignment at all times, clearances in bearings are to be at a minimum. Any misalignment, particularly in a horizontal direction, can cause end thrust of such a force that it is hardly believable.

Before the adoption of antifriction bearings for intermediate calender rolls, the end of the roll journal usually protruded beyond the bearing housing. This end was used for lifting the roll out of running position by way of a cross bar between two screws, and should it be desired to pinch the end down on a roll, a wedge was driven between the bearing housings. If additional weight was to be put on, this wedge was driven further between the two housings and the rolls would be separated. However, when the antifriction bearings were adopted, these ends were closed in with projections on the housings to engage the lifting screws which were somewhere near the same position in relation to the centerline of the bearing as before. Naturally, the crew would use the nuts on the lifting screws to relieve weight on some rolls and these screws, being off center, caused cocking in the bearing housing. In some cases, this caused bearing failure. This condition has necessitated the redesign of the lifting arrangement of calender stacks so that this lifting can be somewhere near the centerline of the bearings to prevent the housing from being twisted out of line. Little jack screws will also be put in so that the upper rolls can be used to apply pressure on the roll directly underneath.

New hydraulic systems are being designed and installed on calenders for lifting the rolls or adding pressure and, by so doing, it is more convenient to take out or install calender rolls, since the motor lifting arrangement was so located it was inconvenient when removing rolls.

It is most desirous to have as little crown as possible in the lower calender roll. It is very difficult to have the proper crown on a bottom roll to accommodate all kinds of paper due to the various types of paper requiring various numbers of rolls. Usually, a happy medium—or should I say an unhappy medium—is employed. In order to alleviate this situation, a nondeflecting roll has been designed. This nondeflecting roll is still in the experimental stage. However, before many years, it can be expected that a maintenance-free roll will be designed suitable for all purposes.

Due to the length of this paper, I am going to pass up any comments on types of reels, unwinders, and drives. No doubt you have noticed that nothing has been said about antifriction bearings and their lubrication and I will devote the rest of the time to this subject.

Antifriction bearings are made in two types—ball and roller, each is made either rigid or self-aligning. In most cases, rigid bearings must have self-aligning housings and self-

aligning bearings must have rigid housings. On bearings of the antifriction type, the inner and outer races do not have sufficient strength to support the loads which they are capable of carrying; therefore, they must have supports both inside of the inner race and outside of the outer race to support the loads and keep the bearing in perfect cylindrical form.

Mounting of bearings is very important. Provision must be made at all times for expansion and contraction that may occur between two bearings. Provision must also be made for alignment of the bearing, either by a self-aligning bearing or housing, unless the bearings are on very short centers and can be located in perfect alignment with no deflection in the shaft between them. It is recommended that this type of mounting be approved by the bearing manufacturer before adoption.

Bearings are made with very close tolerances. Particular care must be exercised to assure that the shaft fit on which the bearing is mounted is not too tight since it can cause enough expansion of the inner race to reduce internal clearances of the bearing, thereby causing an extra load. This can also occur with the outer race. These tolerances should be closely checked. The larger bearings having taper bores should be set up very carefully to be sure not to take out too much clearance or expand the inner race. This can result in two things; either the splitting of the inner race or taking out the clearance and overloading the bearings.

Taper roller bearings need particular attention when adjusting. It is very easy to tighten up the adjustment enough to cause a thrust load to destroy the bearing and, at the same time, have the bearing turn free. This adjustment should be performed by the most highly skilled mechanic well-versed on the technicalities of antifriction bearings.

Wherever possible, oil should be used in the lubrication of antifriction bearings. Around the wet end, however, it is agreed that a grease will be more effective in keeping out water. In the drier section, oil can be used, which should be specified by the oil supplier after consultations with the machinery manufacturer.

It is established that the average antifriction bearing on driers should receive 3 pt. of oil per min. This large amount of oil is required not from a lubrication standpoint but because of the high temperature to keep the oil flow as rapid as possible and as much as practical to avoid it becoming hot enough to cause carbonization in the bearings. The most efficient oil seals should be employed, both to keep the oil in the bearing and materials from coming into the bearing from the outside.

The dual purpose of antifriction bearings is to retain proper positioning at all times and reduce the running load; particularly, the load during the start-up period.

There have been occasional failures of antifriction bearings where it has been difficult to determine the cause. We have experienced isolated cases where bearings have gone out regularly after a certain period and every check known was made and no discrepancies could be found. Finally, the condition would clear up. All in all, the use of antifriction bearings on a paper machine is a good investment.

As the speeds in the manufacture of paper become higher and higher, it is becoming more necessary that the accuracy of the equipment be as close tolerance as possible. It appears that the difficulties in meeting the requirements of higher speeds are not in proportion to the speeds, but rather the cube or fourth power. This is particularly noticeable in the balancing of rolls, since it is of utmost importance that the rolls be closer balanced than ever before, and it is becoming more and more difficult to obtain materials of sufficient tolerance to meet this requirement. If speeds keep on in the leaps and bounds they have been, it will not be many years before the tolerance on a paper machine will be near the equivalent of that on a jet engine.

Due to these increases in speed, proper recognition must be given to the importance of the building foundation. The foundation of the building and the setting of the foundation plates on which the machine rests must be more rigid than ever before.

The foregoing mentions but a very few of the points of interest in building a paper machine. No mention has been made of cylinder, tissue, or many other machine problems but to go into these would require an indefinite period which is not available at this time.

Drying Problems Encountered on Great Northern's New No. 5 Newsprint Machine

A. E. Levensailor

In October, 1954, we started up a 276-in. Beloit newsprint machine designed for 2500 f.p.m. and were surprised to find when the finished sheet was put on the reel that it was 4% drier on the back than on the front. Tests showed this difference in moisture content was a more or less uniform drop from front to back. This problem has been overcome by the combined efforts of J. O. Ross Co., Beloit Iron Works, and Great Northern engineers and technicians.

The uneven moisture across the sheet made it almost impossible to build a uniform reel of paper, so work was started at once to determine ways of correcting this lack of uniformity. At 1200 f.p.m., the driers required very little steam pressure and appeared to be doing very little work as they were operating at less than half of their designed water-removal capacity.

The first investigation was to determine the uniformity of pressure by taking press samples across the machine at the second and third presses it was found that the moisture content across the sheet was very uniform at the recommended nip pressures and, incidentally, the sheet leaving the third press was found to be in the vicinity of 35% moisture-free.

For the second step of the investigation, the surface temperature of the driers was checked at both front and back positions. The first few wet end driers were found to be at a lower temperature on the front than at the back which we believe was due to the amount of air being pulled into these drier cylinders since this first section was under a vacuum due to maintaining pressure differentials between the three drier sections. By reducing the number of drainage sections from three to two, the temperature difference between front and back drier surfaces was more nearly equalized because it allowed the wet end drier section to operate under a positive pressure.

The only remaining explanations for the uneven sheet moisture were four: (1) the operation of the Grewin system, (2)

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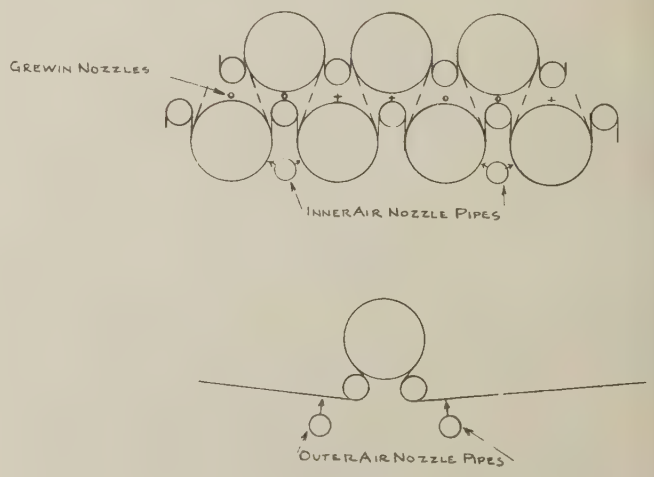

Fig. 1

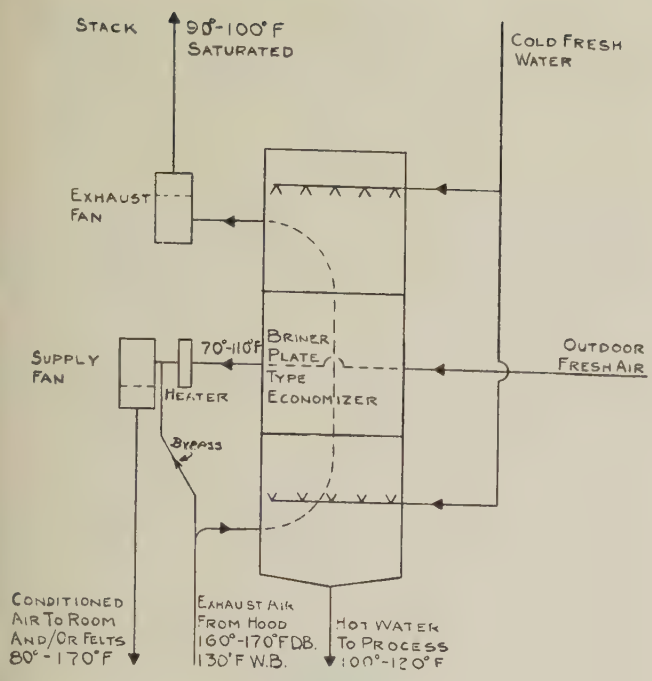

Fig. 2

the air supply system to top and bottom felts, (3) the fact that the steam and condensate headers were inside the hood, (4) that the back side of the machine with its enclosed gears was not symmetrical with the more open front side.

The Grewin system was studied first. The conventional location of nozzles recommended was installed but after start-up they were changed. Formerly they alternated between front and back with all air from the backside nozzles flowing toward the front in the pocket over the top felt rollers. All the air from the front side nozzles flowed to back in the pocket under the bottom drier felt rolls. The change consisted of pairing-up two nozzles, top and bottom, with air blowing to the back, and the next two nozzles, top and bottom, with air jets blowing from back to front (Fig. 1).

The Grewin supply headers were also valved off so that the pressure could be controlled along the driers, as the sheet at the dry end section would stand about 11 oz. air pressure, while in the wet end section the soft sheet would wrinkle with only 4 oz. pressure. Also, the Grewin system was thus made adjustable at front and back sides to assist in equalizing the moisture. The Grewin system proved to be a valuable tool for correcting, in part, this problem but was not sufficient in itself to give the uniformity of moisture required for good machine operation.

The problem was next studied with respect to air flows across the machine, and by use of smoke bombs and air velocity measurements, it was determined that the flow of air was from back to front. Also from wet and dry pulp readings, the air on the front side of the machine contained more moisture than on the back. This tied in with the symmetry of the machine as the enclosed drier gears and frames partially closed the back side. The top and bottom felt supply ducts also are located on the back side of driers and inside the hood.

The first step taken to improve the air exhaust system was to shut down one of the five exhaust fans, open the doors on the inlet side of the other four fans, and recirculate air from hood back to the felt supply system as much as possible without producing condensation inside the hood (Fig. 2). This reduced the volume of new air, as only about 20% of the air is supplied from leakage around the hood. The shutting down of the fifth exhaust fan did decrease the uneven moisture to about 2% difference. This also indicated that the drying efficiency was increased *with lower air volume leaving the machine.*

The next step decided upon were to increase the supply air temperature to design conditions of 170°F., and to reduce the volume of air to that theoretical for 1600 f.p.m.: (1) changing sheaves on the exhaust fans, (2) shutting down the top felt supply fan, and (3) wrapping the bottom felt nozzles from middle to back.

These changes gave an even moisture content across the reel and the machine has operated for the last 6 months up to a top speed of 1850 f.p.m.

Based on the results obtained with the enclosed hood and felt air system on no. 5 machine, some changes have been made on the design of no. 6 machine, which will be starting up Aug. 1, 1955. These changes are mainly to omit the top felt air supply system, as the paper drying benefit from it is questionable, at least to us, to install variable pitch sheaves on all fans (exhaust and supply), and to install a remote control damper on either side of the nozzle central supply pipe. The latter will permit changes in air supply to either side of the machine. Remote control dampers will permit adjustments while the machine is in operation.

It is admitted that the even moisture obtained across the sheet cannot be controlled entirely by any one of the above air adjustments across the sheet, but does give us a measure of flexibility in directing air in the desired direction which will act as a sponge to soak up the moisture where needed.

In learning of the effect of air supplied the paper machine driers from various sources, we hope to obtain not only maximum uniformity in drying of paper, but efficiencies in excess of those thought possible over present-day experience in the paper industry where newsprint speeds are approaching 2500 f.p.m.

LETTERS TO THE EDITOR

Sulphate Pulp Mill Odors

To the Editor, *Tappi:*

The article "Elimination of Odor in a Sulphate Pulp Mill," by P. Ghisoni (*Tappi* 37: 201 (1954)) demonstrates the efforts being made by a modern sulphate pulp mill to overcome odors. There is no doubt concerning the progress made during the last 20 years, but unfortunately the results are not yet satisfactory. Mr. Ghisoni describes the mill, Vita Mayer, near Tradate/Varese, Italy. Spring 1954 I passed through Tradate at noon on a clear and sunny day, with a fresh breeze blowing from the Southwest. The smoke from the high stack was directed slightly upwards and carried 300 to 600 ft. before being destroyed by wind and sun. When we left Tradate on the Northwest outskirts, I and my fellow traveller noticed the well-known odor long before entering the smoke zone, and on going Southeast under the direction of the smoke we experienced remarkable waves of unpleasant odor of sulphur compounds. Our distance from the chimney was now over a mile. The little creek running through the plant stank intensively some kilometers below the plant. The population within a radius of 1 mile from the plant uttered less complaints than people living further off. Some of these complained bitterly. In the Spring of 1955 conditions were unchanged.

Some time ago I also passed the quite modern sulphate pulp mill of Nettingsdorf near Linz, Austria. The odor was very strong at a distance of 1 mile, and complaints were expressed by people living as far as 6 miles away. We conclude, therefore, that in spite of remarkable improvement the unpleasant odor of these plants is not yet abolished.*

* Addition after proof: Weyerhaeuser Timber Co. recently announced a new method (Vaposphere) for combating maladors. The offensive gases are collected in a sphere from which they are then drawn off to be destroyed by burning. It is to be hoped that this procedure will prove applicable for all types of kraft mills and will remove all objectionable gases regardless of their place of origin.

G. Bozza and P. Colombo (*La Chimica e l'Industria* 31: 233 (1949)) found by own observations the limit of perceptibility of methyl mercaptan to be about 1 mg. per cu.m. They refer to an American pamphlet (Fieldner, A. C., Sayers, R. R., Yant, W. P., Katz, S. H., Shohan, J. B., and Leitch, R. D., "Warning Agents for Fuel Gases," U. S. Department of Commerce, Bureau of Mines, Monograph 4, p. 41 (1931)) on the admixture of odorous substances to indifferent gases, in order to make the odor alarming. Here 1.1 mg. of methyl mercaptan per cu.m. are indicated to produce "degree 2 warning effect," i.e., "a weak odor, readily perceptible." This value divided by 14 = 80 gamma per cu.m. gives degree 1 ("just perceptible, threshold"). For ethyl mercaptan, their threshold value is 24 gamma per cu.m. This is 600 times the value found by Emil Fischer (Fischer, E., and Penzoldt, F., *Liebigs Annalen*, 239: 131 (1887)). J. M. Dallavalle and H. C. Dudley (U. S. Treasury Department, Reprint No. 2022, Public Health Reports Vol. 54 No. 2, 1939) give a list of threshold values, which, when present in air, produce a noticeable odor. Relying on data from Fieldner *et al.*, they assume, by mistake, 1.1 mg. methylmercaptan per cu.m. to be the threshold value. This value has been accepted in the literature since.

We extended E. Fischer's experiment on methylmercaptan. Two empty rooms with equal anterooms both having the same size of 40 cu.m. were equipped with fans. In one of the rooms methylmercaptan was distributed by spraying about a solution in methanol. In the other room pure methyl alcohol was similarly sprayed about and distributed by the ventilator for 5 min. We describe two typical experiments out of a greater number:

I. Room A: 40 gamma methyl mercaptan in 10 ccm. of methyl alcohol. Room B: 10 ccm. methanol. 10 observers (students of physics and medicine, no chemists) were instructed that there would be methyl mercaptan either in both of the rooms or in none or in one of them. Five had to step into room A one by one, walk through fresh air for 1 min. and then to enter room B and to write down the result without communicating with each other. The other group of five observers did the same beginning with room B. The result: 9 right, 1 undecided.

Repetition with 20 gamma and 20 observers: 10 right, 9 undecided, 1 wrong. Smokers and non-smokers showed no difference. All of them had not smoked half an hour before the experiment.

Therefore, 0.5 gamma of methyl mercaptan or 0.22 cu.mm. per cu.m. was noticed by 50% of the observers. There is no doubt that a smaller percentage of observers would notice even a lower concentration. It must be added that all observers giving a positive result had a stronger impression of the odor when entering the anteroom of the 40 cu.m. room. There is no doubt that the methyl mercaptan concentration in the anteroom was only a fraction of that in the main room. It is the gradient from fresh air to odorous air which is mainly noticed. Furthermore methyl mercaptan is quickly absorbed by rough walls. We conclude that our value of 0.5 gamma per cu.m. represents a maximum. Possibly the perceptibility of ethyl mercaptan is somewhat higher; E. Fischer, using three observers, found that with 0.043 gamma ethyl mercaptan per cu.m. two were positive, one negative.

The figure, 0.5 gamma per cu.m. means 1 volume of methyl mercaptan in 4.5×10^9 volumes of air (= 2.2 mg. or 1 cc. per 4500 cu.m.). These figures underline the difficulties connected with air pollution in the neighborhood of sulphate pulping mills. We would conclude that a responsible corporation should never establish a sulphate pulp mill in a thickly populated district, especially when the climatic conditions are unfavorable.

KARL FREUDENBERG and MARTIN REICHERT
University of Heidelberg

EMPLOYMENT SERVICE

POSITIONS WANTED

E305-55. Mechanical Engineer. Age 39. Ten years' experience in plant and maintenance engineering, five years' civil engineering. Would be most valuable to an expanding mill where construction planning and supervision experience could be used as well as routine mill engineering. Presently employed in a paper mill.

E312-55. Graduate Engineer. 42. Married. Eleven years in a pulp and paper mill. Experience in engineering, maintenance, and production. Presently employed as superintendent of paper mill making bleached kraft and groundwood specialties—some converting experience. Excellent references.

POSITIONS OPEN

P444-55. Coating Chemist. Excellent oportunity for graduate chemist or chemical engineer with experience in clay coating of enamel and machine coated printing papers. Must be capable of organizing plant scale development work. Location—Midwest.

WANTED

A large two-machine Board Mill Located in Midwest which manufactures high grade folding boxboard will consider applications of young men with practical experience on cylinder machines. Some technical training desirable. Will train for Tour Boss and Shift Superintendent. Send replies to TAPPI, P471-55, 155 E. 44th St., New York 17, N. Y.

P472-55. Chemical Engineer and Chemist. Vacancies exist in a large specialty pulp and paper mill in the Eastern Townships, Province of Quebec. We require one chemical engineer and one chemist. The successful applicants will be employed in the Technical Department. Initially, work will consist of technical investigations throughout the mill aimed at increased production and higher quality. The positions offer interesting work with good opportunities for advancement. Candidates must be recent graduates of a recognized university. Previous experience in the industry is not necessary. Essential qualities are initiative, self-confidence, and ability to work with a minimum of supervision. Apply in writing giving full details of education, experience, and carrier. Naturally all applications will be handled in strict confidence.

P473-55. Challenging opportunity for a Chemist or Chemical Engineer under 35. Experienced in imaginative formulation of plastic coatings and impregnation of paper. Chemist experienced in paint formulation would be given consideration. Old established paper company is diversifying its production. Right man can grow with expanding operations. Please forward complete résumé of personal history, education, and experience with first letter to: The Sorg Paper Co., Attention: C. J. Tranter, Director of Industria and Public Relations, Middletown, Ohio

P474-55. Research Chemist or Chemical Engineer—for group leader in research laboratory of Wisconsin kraft pulp and paper mill. Prefer man with 2–5 years' experience in technical phases of pulp and papermaking, but not necessarily kraft. Salary commensurate with experience. Replies held in strict confidence.

MISCELLANEOUS

A11-55. For sale, three coal pulverizers. These three Babcock and Wilcox type E-56, Class 111-BA coa pulverizers were bought new, have never been used, and are in good condition. They are complete with their primary air fans, motors, controllers, and other auxiliary apparatus. For detailed information write Purchasing Department, P.O. Box 570, Savannah, Ga.

Note: Responses to all advertisements should, unless otherwise indicated, be sent to TAPPI, 155 E. 44th St., New York, N. Y.

Two Paper Machine Drier Roll Explosions*

A SERIOUS paper machine drier roll explosion occurred recently in the Midwest. The machine involved consisted of three sections with a total of 83 rolls. The rolls were 36 in. and 48 in. in diameter and 8 ft. in length. Some of the rolls were comparatively new while others were 30 or more years of age. The first section consisted of 32 rolls, 36 in. in diameter arranged in tier fashion, four high. The second section consisted of 20 rolls, 48 in. in diameter similarly arranged, two high. Thirty rolls of the same diameter comprised the third section with the same arrangement as in the second section. A single felt drier roll was located between the first and second sections. This machine was used to produce a heavy kraft paper with a capacity of 70 tons per day.

Steam was supplied to the mill by a watertube boiler with a capacity of 55,000 lb. per hr. at 350 p.s.i. working pressure, and 600°F. steam temperature. Steam at 45 p.s.i. to the paper machine drier rolls was extracted from a turbo-generator unit. Protection of the rolls against excessive pressure was provided by a 10-in. multiport relief valve, set to relieve at 50 p.s.i. Normal extraction was approximately 28,000 lb. per hr. and the rolls operated at about 38 p.s.i., the difference between extraction pressure and operating pressure being due to line drop. A 10-in. steam line from the power house led to four 6-in. lines which supplied steam to the paper machine. Installed on the 10-in. line, ahead of the 6-in. supply lines, was an air-operated regulating valve which functioned on the basis of the moisture content of the paper. The 6-in. supply lines terminated in an unconventional manner at the three roll sections with no traps or drains installed.

Furthermore, the steam supply lines terminated below the rolls at the first and second sections and midway between the rolls vertically in the third section. The individual roll steam supply was through a $1^1/_2$-in. Johnson joint and the condensate returned through $^3/_4$-in. connections from the internal syphon pipes. Condensate was discharged to two flash tanks, each equipped with a trap to control the liquid level. After leaving the flash tanks the condensate passed through a water heater and was then forced to the boiler plant by a continuously running centrifugal pump (see Fig. 1).

The machine was being rethreaded prior to the explosion. An examination of the recording charts revealed that the steam flow to the machine prior to the paper breaking was 28,000 lb. per hr. After the paper broke the flow dropped to 8000 lb. per hr. The pressure chart indicated that the maximum pressure to which the rolls were subjected was 43 p.s.i. After the machine was started up and shortly before failure occurred the extraction flow meter registered 35,000 lb. per hr. The air-operated regulating valve was being manipulated by hand at that time.

DESCRIPTION OF DAMAGE

It is assumed that one of the rolls exploded first and this shock was responsible for the destruction of four additional rolls and indirectly caused destruction of two other rolls by flying debris. The machine framework was completely displaced at this location (see Figs. 2 and 3). Considerable damage was also done to adjacent sections . . . frames were broken and twisted, driving gears were broken, and the piping was extensively damaged. The building was also badly damaged and a large hole was blown in the roof above the machine. Sections of the walls were blown out and the doors, windows, and electric wiring were damaged in this area. Property damage was estimated at between $75,000 and $100,000, exclusive of the production loss. The machine was out of service for many weeks. Fortunately, no one was injured because the workmen rethreading the machine were not in the immediate vicinity of the explosion.

* Reprinted from *The Condenser*, Vol. 8, No. 1 (April 1955), published by the Mutual Boiler and Machinery Insurance Co.

Cause

The cause of the explosion is not definitely known; however, several conditions may have had a direct bearing on the cause of the accident. Calculations revealed that the rolls were satisfactory for a pressure of 45 p.s.i. with a factor of safety of 10, which is considered normal for cast iron. According to the recording charts, this pressure was not exceeded.

As previously mentioned the 6-in. supply lines to the first and second sections were located below the rolls and midway vertically between the top and bottom rolls in the third section. No drains or traps were provided on any of the supply lines. In the event of a displaced syphon within a roll, a considerable amount of condensate would be present. A temperature differential would thus occur within the metal of any roll in which this condition existed, resulting in abnormal stresses. The possibility of shock by a surge of water hammer should not be overlooked particularly because the rolls may have been weakened previously and because they were under pressure at the time of the accident.

A number of bearings were reported in a poor condition which could have added to the strain on rolls by increasing the torsional stresses. If this condition was excessive, it would be possible for the driving gears to become disengaged imposing severe mechanical stresses in the rolls.

A contributing factor could have been the age of the rolls. All rolls which failed were fabricated in 1920 or before. It was reported that they had been operated by a previous company and that during that time, during peak operation, they were subjected to 100 to 125 p.s.i. steam pressure for sustained periods by the use of a by-pass around the reducing station. This high pressure would, of course, be far in excess of the pressure to which the rolls should have been subjected.

Temperature changes could have been another factor in the failure if the information received is correct in regard to steam superheat. It was reported that at times during varying load conditions the extraction steam to the paper machine contained a degree of superheat. Sufficient expansion and concentration could thus have taken place to eventually cause failure.

In summary, it is believed that the direct cause of failure was due to a pressure wave caused by a condition similar to water hammer combined with one or more of the contributing factors just mentioned.

ANOTHER PAPER MACHINE FAILURE

The failure of another paper machine in Mexico occurred about the same time but from a different cause. The steam supply to this machine was from a turbine as in the previous case, but from a back-pressure unit instead of an extraction turbine. Complete details as to paper machine roll size, age, and arrangement, size of supply and condensate lines and their

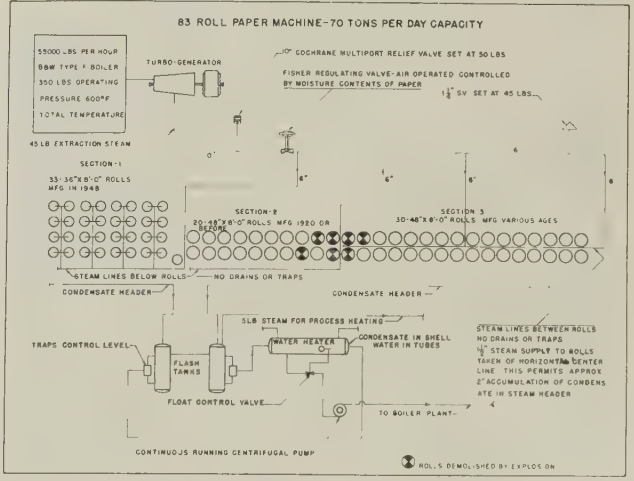
83 ROLL PAPER MACHINE-70 TONS PER DAY CAPACITY
55000 LBS PER HOUR
B&W TYPE I BOILER
350 LBS OPERATING
PRESSURE 600°F
TOTAL TEMPERATURE
TURBO-GENERATOR
COCHRANE MULTIPORT RELIEF VALVE SET AT 50 LBS
FISHER REGULATING VALVE-AIR OPERATED CONTROLLED BY MOISTURE CONTENTS OF PAPER
SV SET AT 45 LBS.
45 LB EXTRACTION STEAM
SECTION-1
33-36"X8'-0" ROLLS MFG IN 1948
SECTION-2
20-48"X8'-0" ROLLS MFG 1920 OR BEFORE
SECTION 3
30-48"X8'-0" ROLLS MFG VARIOUS AGES
STEAM LINES BELOW ROLLS
NO DRAINS OR TRAPS
CONDENSATE HEADER
CONDENSATE HEADER
5LB STEAM FOR PROCESS HEATING
TRAPS CONTROL LEVEL
FLASH TANKS
WATER HEATER
CONDENSATE IN SHELL WATER IN TUBES
STEAM LINES BETWEEN ROLLS NO DRAINS OR TRAPS
STEAM SUPPLY TO ROLLS TAKEN OF HORIZONTAL CENTER LINE THIS PERMITS APPROX 2" ACCUMULATION OF CONDENSATE IN STEAM HEADER
FLOAT CONTROL VALVE
TO BOILER PLANT
CONTINUOUS RUNNING CENTRIFUGAL PUMP
ROLLS DEMOLISHED BY EXPLOSION

Fig. 1

Fig. 2. View of damage to paper machine on side opposite driving end after drier exploded

location in relation to the machine are not available. However, it is known that there was a total of 35 rolls. Overpressure protection was provided for by an adjustable back-pressure valve of adequate relieving capacity on the supply line to the paper machine.

From information received this back-pressure valve was relieving intermittently . . . this being normal to the installation. It is further known that the machine was being rethreaded prior to the explosion.

Description of Damage

Sixteen of the 35 rolls were badly damaged or completely ruined. Extensive damage was done to the machine framework, bearings, and to the building housing the machine. In addition to the great amount of property loss, three men were killed and a fourth man was severely injured.

Cause

The exact cause of this explosion is not definitely known but some conditions were noted which point to a plausible answer. As previously mentioned, the machine was protected by an adjustable back-pressure valve set to relieve at a pressure within the range of the safe working pressure of the rolls. With no paper in the machine, or while rethreading, the demand for steam would be less than during normal operation;

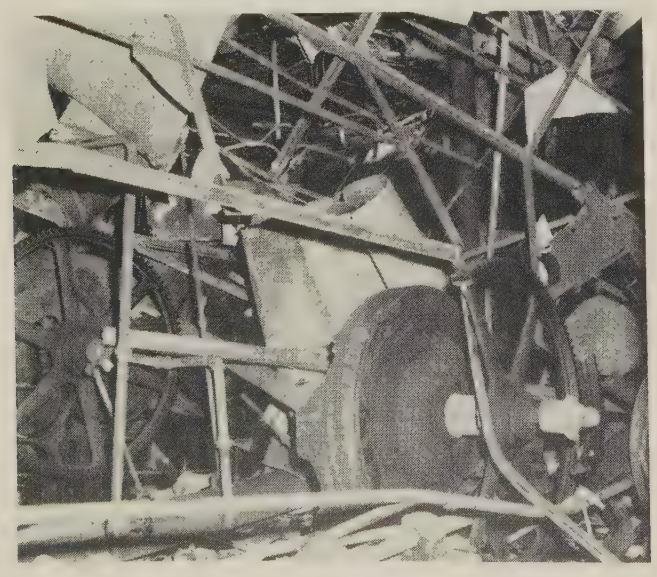

Fig. 3. Shows extensive damage on the drive side of paper machine

Fig. 4. View of damage to building

therefore, the relief valve would be in operation at least intermittently. The disturbing influence to personnel of a safety or relief valve in operation is well known to all those who are familiar with this type of equipment. Apparently someone adjusted the relief valve to minimize the noise caused by the operation of the valve. It was understood that the valve continued to relieve after the explosion but had been so adjusted to cause restriction of exhaust steam flow and subsequent build-up of pressure beyond the safe working pressure of the rolls. A sealing or locking device on the adjusting mechanism of the valve might have prevented tampering with the valve. Figures 3, 4, and 5 show the great extent of the damage caused by this explosion.

CONCLUSIONS

The installation of paper machines and particularly any pressure changes should be carried out under the supervision of competent engineers thoroughly familiar with equipment of this kind. The assignment of a qualified engineer to the establishment and control of operating and maintenance practices is strongly recommended. It should be his responsibility to see that proper procedures are followed and to act as a clear-

Fig. 5. Shows extensive damage to paper machine

ing house on proposed changes for paper machine operation.

To extend the life of driers and to prevent failures the following recommendations are made:

1. All sections of the paper machine should be protected adequately against overpressure with safety valves. The safety valves should be of sufficient size and capacity to discharge all the steam that can be supplied to the rolls through a reducing station, a live steam make-up line, an extraction line, or the exhaust from a turbine.

2. Steam headers and laterals should be properly pitched and provided with a sufficient number of traps or manually operated drains to prevent the accumulation of condensate.

3. The drier rolls should be kept free from condensate; this requires that the syphons be intact in place and functioning properly. A weekly check of the surface temperature of each drier will give a good indication as to whether the condensate is being removed properly. The most common failure of drier systems to function properly is lack of a proper pressure differential across the driers. Two pressure gages, installed at each steam joint in the steam and condensate sections, will indicate whether a proper differential exists.

A visiflow in the condensate line will permit a check on whether water is moving freely.

4. Drier gears and bearings should be kept in proper alignment. Clutches should be kept properly adjusted to prevent grab on engagement.

5. Drier rolls should always be rotated while they are being warmed up. While warming up driers, they should be rotated slowly and the steam admitted at low pressure for at least 30 min.

6. Driers should also be rotated for a cooling off period while shutting them down after the steam has been shut off.

7. Whenever drier heads are replaced, great care should be used in drawing up the head bolts uniformly. A torque wrench should always be used and the bolts should be torqued in accordance with the manufacturer's specifications. If leakage develops at any time between the joint of the head and shell the head bolts should not be drawn up excessively at that area to try to stop the leakage. All the head bolts should be drawn up an equal amount with a torque wrench and, if leakage still persists, the head should be removed to permit examination of the joint.

Before the speed of any paper machine is increased or the pressure is raised on the driers the effects of these changes should be discussed with the insurance company.

Fig. 6. Another view of damage to paper machine

Readers are also referred to Accident Prevention Bulletin 6.01 on "The Cause and Prevention of Dryer Roll Failures" published by the Mutual Boiler and Machinery Insurance Co. which discusses these and other features of drier roll operation and maintenance.

The Importance of Optical Bleaching Agents in the Paper Industry

L. WIMMER

THE majority of papers of all types used are white in color. Consequently, it has long been a problem of first importance to improve the whiteness of paper. For this, a number of processes are necessary, and these may be summed up under the following heads:

1. Careful cleaning of the raw materials and stripping to remove impurities.
2. Destruction of the yellow or yellowish-brown coloring matter in the raw materials by bleaching.
3. Neutralization, by means of compensating dyestuffs, of colored residues that still remain.
4. Application of fillers, sizes, etc., which are themselves of the best possible natural color (in this case, white).
5. Application of optical brightening agents.

Since the use of optical bleaching agents to improve whiteness in paper has increased in importance over the past 10 years, it may be useful to consider their action, application, and properties.

THE ACTION OF OPTICAL BLEACHING AGENTS

The method of dyeing a paper white generally in use today consists in neutralizing the yellowish color of the raw stock that persists in spite of thorough cleaning and bleaching. This is done by cross-dyeing with compensating dyestuffs, and turns the stock a pale gray, a shade which is visually more acceptable than the natural yellowish tint. In practice, however, the addition of blue-to-violet compensating dyestuffs gives rise to an off white, that is, to a loss of reflected light. The use of optical bleaching agents (a good deal of literature has already been published on their application and properties) gives a great improvement in visual brightness, without altering the basic color tone.

Also, in the final stage of the bleaching process, damage to fibers is very easily caused by an excess of chemicals, while the extra whiteness obtained thereby is not very considerable. With a good optical bleaching agent, on the other hand, a considerably greater increase in the degree of whiteness can be obtained without affecting the fibers.

Appearance, Composition, and Properties

The products are almost always marketed as yellowish-white or yellowish-brown powders. Their chemical structure is highly complex, and it is outside the scope of a short lecture to describe it, beyond saying that the substances are derivatives of coumarin, diaminostilbene, benzimidazol, diaminobenzol, diaminophenyl urea, diphenylimidazolan, phenylbenzothiazol, triaminophenyl ether, etc.

They vary greatly in solubility. Many are only slightly soluble (1 to 2 grams per liter): others are readily soluble in water. Thus, for example, a solution of Tinopal 2B or 2BP at 50 grams per liter can be kept almost indefinitely in the cold without flocculation or crystallization. Naturally, exposure to light reduces the efficiency of the solution. Some products act as substantive dyestuffs, and exhaust completely on to the cellulose fibers; others enter the backwater and give their most effective yield at the sizing stage; others are not completely fixed even with hard sizing.

The products vary in fastness to light from good to moder-

L. WIMMER, Engineer, J. R. Geigy, S. A., Basle, Switzerland.

ate. Those which do not yield colored degeneration products when exposed to light are to be preferred.

It would take too long to list all the agents on the market so only those which are extensively used in the paper industry are mentioned:

Blankophor R, B and G extra high conc. (Bayer)
Leucophor R, B and BS (Sandoz)
Uvitex RS, RT and P concn. (Ciba)
Tinopal 2B, 2BP and GS (Geigy)
Pontamin White brands (Du Pont)
Paper-white brands (Gen. Dyestuff Corp.)
Calcofluor brands (Calco)
etc. etc.

A good optical bleaching agent should fix on unsized as well as on all sized papers. This is a necessary requirement for economic application. The paper technologist and the beaterman require a good solubility to avoid handling excessive quantities of liquor when applying the agents in the pulp. Another requirement is a neutral shade, one that tends neither toward red nor green, so that there will be no need to shade later, a procedure which always causes color variations. Lastly, good fastness to light and permanence are requirements that go without saying.

Brightening Effect

The brightening effect depends in the first place, on the amount of optical white used. The natural color of the fibers is also of great importance. The duller and more yellowish the cellulose, the smaller the brightening effect, or, to put it another way, the greater the amount of optical bleaching agent needed to obtain a certain degree of whiteness. The natural color of the loadings most in use, such as talc, kaolin, china clay, aniline, and lenzine, varies from yellowish to yellowish-brown, according to their source and the method of their preparation. This natural color is sometimes very dull and can affect the brightening in the same way as the sizing materials do. Rosin, for example, varies in color from pale yellow to dark brown, however, some emulsions containing free resin may appear to be white.

All these undesirable effects have to be offset by adding a larger amount of optical bleaching agent. Thus, the simple principle may be expressed that the brighter the color of the raw and auxiliary materials, the smaller the quantities of optical bleaching agent necessary, or alternatively, the greater the improvement in the degree of whiteness.

The author would, however, specially emphasize what has already been said about the action of optical bleaching agents, namely, that a far higher degree of whiteness can be obtained with very small amounts of such agents than can be obtained in the final stage of conventional bleaching. Consider, for example, high quality rag papers, such as cigarette papers, in which it is almost impossible to avoid some damage to fibers by bleaching to a high white. This can cause a loss of strength that will make the paper quite unsuitable for use on modern high-speed cigarette-making machines. Here, clearly, the use of a good brightening agent is more economical and safer in the manufacturing process than merely chemical bleaching alone. The number of examples can be multiplied, but the one given illustrates quite clearly the importance of optical bleaching agents in the paper industry today.

APPLICATION

Good optical bleaching agents, being simple to use, may be applied without difficulty at any stage in the manufacture of paper or board. Thus, they can be applied (1) in the pulp; (2) in the dipping process; (3) during coating, whether by spray, brush, or any other method of surface application.

Application in the Pulp

The most usual method is to apply the brightening agent to the pulp in the beater. Excellent effects are obtained with amounts as low as 30 to 100 grams per 100 kg., i.e. 0.03 to 0.1% on the dry weight of pulp. The amount is varied according to the degree of whiteness desired, but it also depends on the natural color of the raw or auxiliary materials used. The brightening agents are dissolved in hot water (about 1 part in 20), diluted with cold water, and added gradually to the beater, or even before the beater. The products vary in their affinity for cellulosic fibers. Some, like Tinopal or 2BP, have a strong affinity and exhaust within a few minutes similar to substantive dyestuffs. When the substance has been well distributed, sizing follows as usual. It is important to keep to this order of addition since any change in it may lead to failures. If for example, the optical bleaching solution is not added before the aluminium sulphate, a precipitate may result which is less efficient as a brightening agent. Naturally, the optical bleaching agents can be added before the refiner. Shading in any desired direction can also be carried out at the same time as the optical bleaching agent is added. However, it is preferable to use a second optical bleaching agent as a shading agent rather than a dyestuff, for example, a greenish product if the first product gives a reddish shade. Solutions should always be made up fresh and not exposed for long to strong sunlight, otherwise the efficiency of the product may be impaired. This applies particularly to solutions at weaker concentrations. Though weaker solutions are not especially fast to light, it must not be assumed that the light fastness of the brightened papers is poor. The fastness to light of most optical bleaching agents is good to adequate. The author would merely like to stress that, for example, Tinopal 2B and 2BP yield color less products of decomposition when exposed to daylight (Fadeometer readings are contradictory and do not reflect natural conditions), whereas certain optical bleaching agents yield yellowish or yellowish-brown products of decomposition and thus are not so fast to light as Tinopal 2B and 2BP.

Application by the Dipping Process

Machine-made papers are often subjected to an after-treatment process, such as impregnation, creping, etc. Here the brightener may be suitably applied at this stage. Good results are obtained with amounts of 40 to 100 grams to 100 liters of impregnating liquor. Such solutions are easily prepared. The optical bleaching agent is dissolved in a little hot water and then added to the liquor. As many papers are sometimes sized in the size press, this process can be combined with that of optical bleaching without difficulty. In this case the optical bleach is added in aqueous solution to the size batch. It is much more economical to apply the brightener in this way than in the beater, because the paper is only superficially brightened. Since the brightening effect is, in any case, noticeable only on the surface, only one half to one third of the quantity needed by the pulp is required by this method.

Application by Coating

In coating, fillers are used, such as blanc-fixe, talc, china clay, kaolin etc., with adhesives, such as casein, starch, dextrin, gelatine, animal glue, etc. These products cannot be said to be perfectly white, so that here, too, is a wide field of application for optical bleaching agents. The addition of the optical bleaching agent to the coating layer in amounts of 50 to 150 grams per 100 liters improves the whiteness to a remarkable degree. Every effort is made nowadays to lower the viscosity of the coating layer and thus a high yield with a thin coating is obtained. Obviously if the coating is thinner, more brightener must be added and vice versa.

A point which can give rise to practical difficulties should be mentioned here. In preparing coating layers on a casein basis the casein is dissolved with alkalies, such as sodium hydrate, borax, chalk, ammonia, etc. The nonvolatile alkalies, however, give the paper, on drying, a more or less yellowish color, depending on the amount contained in the coating solution. This reduces the brightening effect. In

preparing coating solutions, therefore, care should always be taken to avoid using excessive nonvolatile alkalies, or to replace these if possible by volatile alkalies, such as ammonia, which evaporates in drying and does not cause yellowing.

Recent experience has shown that paper can be coated even in the paper machine; that is, a layer of coating can be applied with a thickened filler dispersion on one or both sides of the paper while the paper is still wet, and it fixes very well. At this stage too, an optical bleach can be applied successfully, and gives a marked improvement in whiteness.

IMPORTANCE OF OPTICAL BLEACHING AGENTS TO THE PAPER INDUSTRY

The optical bleaching agents are a valuable help toward improving whiteness in paper. In the first place they can be used to obtain a whiter appearance unobtainable by bleaching processes with the advantage to the papermaker that damage to fibers by excessive chemicals can be avoided, and much time can be saved in comparison with the bleaching process. The subsequent application of a brightener, whether in the beater or during after-treatment, does not entail any significant extra costs for these are more than offset by the saving on chemicals, time, steam, and wages. In other words, products of equal visual whiteness but usually of greater durability are obtained at the same or lower cost.

Secondly, optical bleaching agents are a means of offsetting the dulling caused by yellowish-white fillers and sizes. In dyeing pale shades both in the pulp and at the dipping and coating stages, the addition of an optical bleaching agent increases the brightness of the dyeing. This is, of course, true only of the pink, blue, and violet shades, which tend more toward blue and become considerably more brilliant. With yellow, orange and green shades there is only a slight lessening of the yellowing. Nowadays white or pale colored cotton or rayon fabric is seldom seen that has not been treated with a brightening agent, and the same trend is noticeable in paper bleaching.

Although the general tendency is toward the production of lighter background shades in the paper industry, there will always be papers and boards in which the use of an optical bleaching agent gives no marked improvement in color, or is uneconomic for example, with grey and brown boards, kraft wrapping paper, newsprint, and many other types. At the same time, among high-bleached papers today high whites are found on the market of a quality hitherto unknown; and these can only be obtained with the help of an optical bleaching agent.

This section would not be complete without a brief survey of the problem of brightening unbleached cellulose and wood pulp. Here the application of an optical bleaching agent can improve the background whiteness, but it cannot give the degree of whiteness obtained in a high-bleached cellulose. The author must therefore emphasize again that the use of a bleaching agent is reasonable and economic only if no marked improvement in whiteness can be obtained with bleaching agents if for any reason an afterbleach is not feasible, or if it is necessary to offset the dulling that may occur at various stages in the transformation of cellulose into paper.

MATCHING

Since the transformation of invisible ultraviolet rays into blue light rays implies the existence of ultraviolet rays in the first place, the inspection of the white dye should only be carried out in good daylight. If brightened paper is to be matched during manufacture by artificial light, a good daylight lamp is essential.

In an emergency it is possible to go ahead with a formula ascertained by daylight with a minimum of alteration; and the intensity of fluorescence observed under filtered quartz light can also give valuable indications. But these can only be considered as emergency measures.

The various apparatus for testing whiteness, all of which use an artificial light source, do not give the results obtained visually by daylight. Naturally this applies also to daylight lamps. Experiments are going forward in this field, and it may be expected that as a result of modifications to the testing apparatus it will be possible to obtain perfect measurements in the not so distant future.

TESTING OF OPTICAL BLEACHING AGENTS

When testing optical bleaching agents the filler must be omitted to avoid any side effects that may be caused by variations in the type or quantity of filler used. The test should also be made with several different strengths or concentrations as, on the one hand, there are products which brighten well with a weaker concentration but the efficiency does not increase proportionately with an increase in strength. On the other hand some optical bleaching agents have a moderate effect in weaker concentrations and have a proportionately stronger effect as the concentration is strengthened. This may be expressed statistically by saying that the relative efficiency of two optical bleaching agents in weak concentration may be 1:2, while in a stronger concentration it is 1:1.4. This is the case with Leucophor R and Tinopal 2B.

The test should also cover solubility, fastness to light, and permanence. In some cases special tests are necessary, appropriate to the use of the paper. For example, if the optical bleaching agent is to be used to improve the whiteness of materials for parchment papers, the test papers treated with the optical bleaching agent must be tested for resistance to sulphuric acid at 54° Bé. Some products have been found to break down completely under acid treatment; Tinopal 2B and 2BP on the other hand withstand it well.

HARMLESSNESS OF OPTICAL BLEACHING AGENTS

Since optical bleaching agents are widely used for improving the color of cigarette papers, food wrappings, hygienic papers, and so on, it may be asked whether any toxic or noxious properties have been found in them. This question led to extensive research. The following statements apply only to Tinopal 2B and 2BP, since the author does not know what tests have been made by other manufacturers in this direction, or with what results.

It was known beforehand that these products were nontoxic and did not irritate the skin. A lethal dosage was established by feeding the products to rats and mice, and it proved to be so high as to represent a dosage of 350 to 500 grams for man. Of course this figure does not mean very much, for it leaves out of account the fact that man has a much stronger constitution and might well be able to tolerate much higher dosages, or that natural secretion would prevent the accumulation of lethal amounts in the organism.

Accumulation within the body, however, can never occur for the following reasons; in cigarette papers the traces of optical bleaching agent, because it is an organic substance, are fully combustible, and in all other types of paper the optical bleaching agent is so firmly fixed, owing to its high affinity for cellulosic fibers, that no traces have ever been found in foodstuffs wrapped in paper that has been treated with Tinopal.

Let us assume, that the statement regarding cigarettes is not true, and that, for example, a heavy smoker consumed the cigaret paper of two packages a day and there was no secretion of the optical bleaching agent from his body. He would have to live 600 years in order to die of Tinopal. Our natural apprehensions have led us to discuss the optical bleaching agent, and in doing so we have ignored the question of nicotine. We all know that nicotine is a strong poison, and can be fatal to a nonsmoker in quantities as low as 0.1 to 0.2 grams. But our heavy smoker will in the course of 60 years have passed through his organism no less than 37 to 40 kg. of nicotine without succumbing to its effects.

Lecture given at the conference on paper and cellulose technology, Graz, Austria, July 2, 1953.

The Oxidation of Sulphate Black Liquor and Related Problems

T. T. COLLINS, JR.

WITHIN the last 5 years there has been considerable interest in the field of sulphate black liquor oxidation. Most of the basic work that has been publicized has been carried on by a few groups of investigators. In some cases the role of oxidation was developed as an adjunct to other parts of the kraft recovery system and it is interesting to list them.

1. The Bergstroem-Trobeck (B-T) foaming type of oxidation system has been developed in Sweden in conjunction with high pressure evaporation of black liquor to a dry powder.
2. Tomlinson and his group in Canada have used a nonfoaming oxidation tower as a part of the "secondary recovery system." This also includes the cyclone evaporator for black liquor concentration followed by the "deluge scrubbers" for salt cake fume removal and a condensing tower for the production of hot water from the stack gases. Recently the B-T and the Tomlinson systems have been combined for marketing.
3. Wright and co-workers of the British Columbia Research Council have studied various aspects of the problem and a tower packing for an oxidation system being developed for five Canadian mills. This unit has been tested on relatively nonfoamy liquors and is designed to avoid the production of foam.
4. Bialkowsky and DeHaas have also investigated and operated a nonfoaming type of tower on relatively nonfoamy liquors.
5. Collins has devised an oxidation system for the production of excessive quantities of foam from both foamy and nonfoamy black liquors. The application of this unit is another step in the "fume-heat-sulphur recovery process" for the reduction of stream and air pollution. This originated with the author's original work on the venturi-scrubber (U. S. pat. 2,604,185 and foreign patents, issued and pending).

These investigations, and others as yet unpublicized, have resulted in the installation of a number of full scale oxidation systems of both types in the United States and Canada as well as abroad. Most of the units in North America have been of an experimental nature with development being carried on by the mills themselves. Apparently the same trend still exists since it is rumored that the problem is being investigated in several mills. That is undoubtedly due to the fact that there is no successful unit currently advertised and offered on the market.

For further clarification of this subject, it is of interest to continue a previous article in which the literature and patents covering the subject of black liquor oxidation were reviewed by Collins (*1*) almost 2 years ago. Since then, a number of other references have appeared. The Canadian equivalents of two United States patents listed in the earlier review have been granted to Kress (*2*) and Tomlinson and Tomlinson (*3*).

A note (*4*) from the 8th Annual Report of the British Columbia Research Council mentions that a pilot plant oxidation unit was operated at the Port Alberni, B. C., mill of MacMillan and Bloedel, Ltd. Sufficient liquor was oxidized to allow a full scale mill run through the system. Changes in odor release were studied and it was demonstrated that the oxidation system is capable of absorbing the odors released by the digesters.

Wright (*5*) of the British Columbia Research Council has continued his study of oxidation tower design with black liquor flowing down vertical sheets having a surface imprint to retard the rate of flow and thus increase the contact time, while avoiding formation of foam. Vertical strips of packing with various surface configurations had black liquor circulated over them with hot, saturated air passing concurrently along the strip. The drop in sulphide content of the liquor with time of contact with air was noted. Liquor samples normally were kept in sealed bottles and when needed for test were displaced from storage with nitrogen. The empirical data were plotted and calculated curves for a first order reaction plotted from a part of the data coincided very well and extended the relationship to higher sulphide contents. From the data a procedure for estimating the size of oxidation towers was established. Size is based primarily on using a definite packing surface configuration which for a liquor containing 4 grams of Na_2S per liter calculates to an oxidation of approximately 0.04 lb. of Na_2S per hr. per sq. ft. of packing on one side. (*Note:* "Packing area" for a square foot of packing is actually greater than 1.)

Schoening, Shemilt, and Wright (*6*) have described a pilot plant in which asbestos-cement sheets with a "diamond" surface pattern imposed upon them were used for the tower filling. In addition to the oxidation tower, a system was set up whereby a proportional amount of digester blow vapors could be passed through a surface condenser and the noncondensable gases passed into the oxidation tower. Data show an almost complete absorption (and oxidation) of the methyl mercaptan and hydrogen sulphide in the liquor in the oxidation tower. This amounts to a sulphur saving of about 4 lb. per ton of pulp calculated as salt cake.

Using a large supply of stored liquor prepared in the previously mentioned pilot plant, Wright, Schoening, and Shemilt (*7*) were able to supply oxidized black liquor to the mill for about 5 hr. Samples of black liquor, evaporated condensate, evaporator noncondensable gases, noncondensable furnace gases, and condensable and noncondensable stack gases were analyzed for their sulphide and mercaptan content both during and after the period of operating on oxidized liquor. A considerable reduction in the loss of sulphur gases at various locations occurred during the run on oxidized liquor. These investigators call attention to the Weber-Fechner Law as applied to the olfactory organ whereby the intensity of the sensation is proportional to the logarithm of the intensity of the stimulus. They correctly point out that since it is a matter of presence or absence of odor rather than intensity as far as the public is concerned, odor control systems would be judged on an all-or-none basis. (*Note:* Where masking agents are used to change the character of the kraft smells and make them more acceptable to the public, there is probably no quantitative reduction in the loss of sulphur gases as is achieved by liquor oxidation and other processes.)

A very interesting item (*8*) regarding the patent aspects of black liquor oxidation has recently appeared. Originally, the Board of Patent Interferences of the U. S. Patent Office awarded priority of invention to Tomlinson on a count covering the basic process of oxidation over an application filed by Bergstroem and Trobeck under the Boykin Act. The Tomlinson application was filed Jan. 10, 1946 and the Bergstroem-Trobeck application was filed Feb. 17, 1948 under the Boykin Act and covers Swedish patents 120,988 and 128,263, filed in Sweden Aug. 28, 1939 and June 13, 1941 respectively. This decision has been reversed by the Court of Customs and Patent Appeals and priority has now been awarded Bergstroem-Trobeck. It is outside the scope of this paper to comment on this matter but anyone interested should consider these decisions in the light of the literature review (*1*) published by this author.

Tähtinen (*9*), in reporting on a Bergstroem-Trobeck oxidation system installed in the Oulu mill in Finland, mentions the influence of the strength of black liquor on the degree of oxidation. He says that the oxidation plant does not operate satisfactorily due to difficulties with the foam-breaking apparatus.

Ghisoni (*10*) has described the odor control program in the sulphate mill of Vita Mayer & Co. on the Olona River in

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Italy. The use of an oxidation tower with the noncondensable gases from the vacuum evaporators passing into it is shown.

The early work of the author of this paper in the field of black liquor oxidation has been covered in the previous review. The advantages and limitations of black liquor oxidation were described at that time. Subsequent work has uncovered nothing that does not correspond with those early findings and predictions. In the 1950 paper (*11*) covering the first full scale installation of the oxidation system developed as a part of the "fume-heat-sulphur recovery process," a discussion was given of the relationship of black liquor oxidation to (1) the residual sulphide content of the black liquor, (2) the operation of the furnace with sufficient air to reduce the generation of hydrogen sulphide and to convert it to sulphur dioxide by proper combustion, and (3) an adequate scrubbing system for absorbing the sulphur dioxide from the stack gases without release of hydrogen sulphide from the scrubbing liquid.

The final requirements for a successful scrubber for the "fume-heat-sulphur recovery process" have now been met by the use for over a year of a black liquor venturi-scrubber on a 250-ton furnace at the Thilmany mill at Kaukauna, Wis. There is a recently installed unit of smaller capacity at the Bare mill in Roaring Springs, Pa. These units are technically and economically successful and, although not operated in conjunction with oxidation systems at the present time, provide equipment which would enhance the benefits of black liquor oxidation to the mill sulphur balance and odor control problem by absorbing sulphur dioxide released in the furnace without the addition of alkali in the scrubbing liquid. In turn, oxidation systems greatly reduce the large quantity of hydrogen sulphide which is normally lost from the black liquor in the direct contact evaporators. Coupled with simple means for absorbing and oxidizing the sulphur gases lost in turpentine relief and digester blow vapors, a considerable quantitative reduction in the sulphur gas release of the mill may now be accomplished. In addition, where low salt cake make-up is employed, the combination of the black liquor venturi-scrubber and the presently discussed oxidation system make it possible to maintain the mill sulphidity level at an appreciably higher value than would be possible with conventional equipment. This is also of importance where extra sulphur is being added to maintain sulphidity or where, because of salt cake shortage, the use of make-up chemicals with a lower sulphur to sodium ratio to replace salt cake is contemplated.

Since the development of a technically successful and economically justifiable oxidation system by the author in the 1946–49 period, progress has merely been further application on foaming and nonfoaming liquors and design refinements. Some preliminary tests have been made in laboratory comparison of the foaming characteristics and foam stability of black liquor samples from various areas. The method of Ross and Miles (*12*) has been used on samples at room temperature and essentially the procedure consisted of running a 250-ml. sample of black liquor from a dropping funnel through a $^3/_{32}$ in. i.d. capillary whose outlet was $45^1/_2$ in. above the surface of a 50-ml. sample of liquor placed in the bottom of a $1^7/_8$ in. i.d. glass tube. The height of the layer of foam created when the last of the sample from the funnel dropped into the liquor in the bottom of the tube and the stability of the foam relative to time of standing were noted. It was found for all liquor samples tested that the volume of foam, once it was formed, did not decrease to any appreciable extent within 20 min. but there was considerable drainage of liquor from the foam.

There is no question but that this method of measuring the relative foaminess of various black liquors needs to be investigated and improved upon. However, it does give some indication of differences in the various liquors and the oxidation system is easily designed to compensate for them.

Another item in conjunction with the analysis of black liquor for its sulphide content appears to be of some interest. In an earlier paper (*13*) on various methods for analysis of oxidized black liquor, for the electrometric titration using silver nitrate, an arbitrary end point for the completion of

Table I. Height of Foam Column Formed from Various Black Liquors

Liquor source	*Solids, %*	*Height of foam, in.*
Dry lodgepole pine	18	3.5
Southern pine	16	5.75
Southern pine[a]	27	5.75
Canadian[b]	15	0.62

[a] After soap skimmer in evaporators.
[b] Wood 65% balsam and 35% spruce. Cut winter 1951–52 and pulped May, 1953.

the sulphide reaction was assumed. In recent work, an attempt was made to locate the end point (the steepest point of inflection) of the titration curve by the method mentioned by Daniels (*14*) and illustrated by Fig. 1. The differential graph may be obtained by drawing tangents at points on the voltage curve or, preferably, it may be taken directly from the original data by dividing the difference in voltage by the corresponding difference in milliliters and plotting that ratio against the intermediate volume of reagent. Because of oxidation of the solution while it is stirred, the instability of the millivoltmeter readings as the silver nitrate slowly reacts in the solution when the titration curve is in the inflection zone, etc., the peak of the differential graph does not fall at a particular voltage value on successive titrations. Therefore, one may just as well choose some arbitrary voltage as the endpoint. It would be interesting to see more work done on this particular phase of the problem.

According to various investigators, in general there are a number of beneficial results at various points of the kraft process from the oxidation system.

1. Vacuum evaporators—Longer tube and liquor line life, cleaner condensate, and lower sulphur loss. There is apparently a better separation of soap ahead of the evaporators. Oxidation also results in 1 to 2 points in percentage higher solids in the liquor to the evaporators so that some slight heat gain is effected and evaporator capacity is increased. Condensate and condenser water are claimed to be suitable for use in hot ponds, causticizing washes, etc.

2. Cascade or direct contact evaporators—The loss of hydrogen sulphide from liquor at this point is eliminated to a great extent.

3. Recovery furnace—The generation of hydrogen sulphide within the furnace is reduced due to better combustion and the release of sulphur dioxide instead. This reduces the unpleasantness of the stack odor. For some types of furnaces, oxidation of the black liquor is said to improve combustion.

4. Causticizing—The higher sulphidity of liquor resulting from oxidation makes possible an appreciable saving in lime.

5. Cooking—The sulphur compounds in digester blow gases and turpentine noncondensable relief may, to a considerable extent, be absorbed and oxidized in the system with some sulphur saving and a reduction in mill odor. Many advantages from the use of higher sulphidity cooking liquor have been listed by Hägglund (*15*) and others. Among them are shorter cooking time required to yield pulp of a given lignin content; higher yields; higher tensile, bursting, and tearing strengths; more resistance to shortening of the fibers upon refining, etc.

6. Chemical make-up—When extra sulphur is added to maintain sulphidity, oxidation will reduce the amount needed, if not eliminate it entirely. Lower sulphur losses from the system make possible the use of salt cake substitutes that have a lower sulphur to sodium ratio than salt cake.

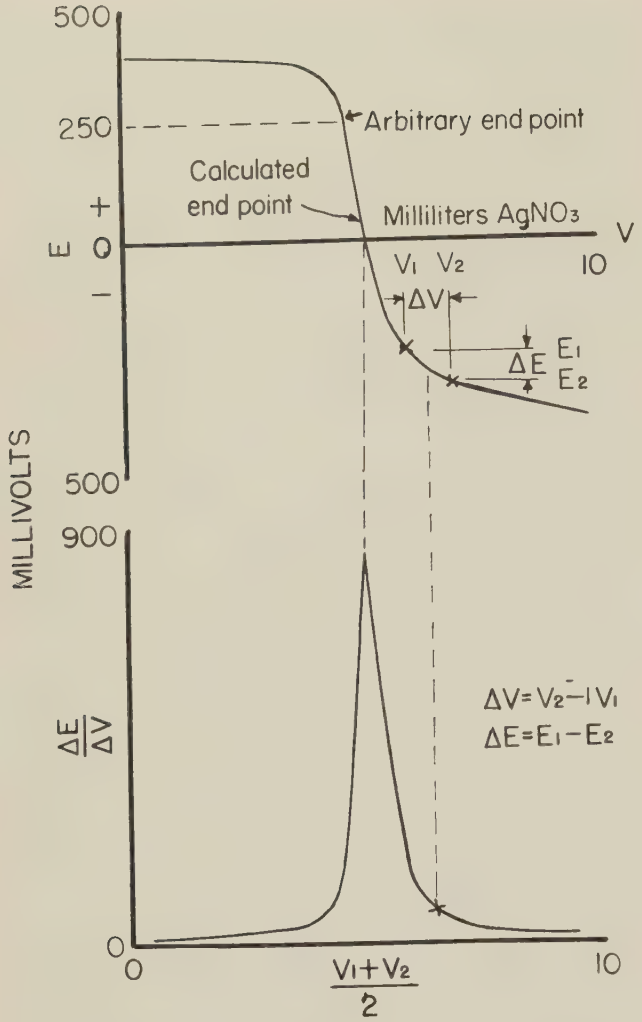

Fig. 1

As for disadvantages of oxidation, the only one that can be foreseen is a probable increase in corrosion in the green and white liquor systems resulting from the higher sulphidity.

Table II summarizes the data reported for full scale operation of various oxidizing systems as regards the sulphidity increase and the resultant saving in lime.

Table II. Lime and Sulphur Make-up Savings and Sulphidity Increases Due to Oxidation Systems

Source	*% Sulphidity raised from*	*Points percentage raised*	*Lime saved, (lb. per ton pulp)*
Trobeck (*16*)	26.1 to 28.7	2.6	14.2
Collins (*11*)	21 to 25 (total)	4	25 (est.)
Tomlinson (*17*)	27–31 to 35–38	8.5 av.	...
Bialkowsky (*18*)	16[a] to 20 (total?)	4	...

[a] Make-up of 18 lb. sulphur per ton pulp was also eliminated with oxidation.

From the standpoint of economies achieved by oxidation, the lime saving appears to be the most important with other phases, such as its effect on evaporation, the over-all heat balance, etc., being of secondary importance in most mills. Figure 2 illustrates the calculated lime savings to be expected when the mill sulphidity is raised by oxidation or otherwise. It will be noted that various constant conditions are assumed. For example, if a mill is operating at 20% sulphidity (total) and oxidation raises the sulphide balance to 25%, an estimated lime saving of 21 lb. per ton of pulp would result if we consider only half of sodium sulphide is used in pulping (effective alkali). A 34-lb. lime saving would result if all the sulphide is used in pulping. Actually, it is probably conservative to use an intermediate figure.

The value of the lime saved then becomes another factor that affects the economics of oxidation. If all new lime is being used then savings are appreciable. If reburned lime is used, then about all that can be credited is the fuel saved. Although each mill will have to figure for its own conditions, one set of calculations based on 25 lb. lime per ton of pulp saving and a kiln operating on 12,000,000 B.t.u. per ton of lime on bunker C fuel at 5.2¢ per gal. showed a fuel saving of $10,500 per year for a 600-ton mill. This amount is midway between the high and low estimates for the operation and amortized construction costs of a full scale system for a 600-ton mill in the south. Actually, it is expected the cost figures for oxidation will be lowered if certain modifications in mill liquor storage tanks, washer foam breakers and foam tanks, etc., now under development are successful due to tie-in with the oxidation system and resultant economies are credited to it.

For large oxidation systems of proper arrangement, there are 0.083 hp. installed per ton of daily pulp capacity or a power consumption of 1.5 kw.-hr. per ton of pulp. This coincides with earlier findings of the author (*11*) and should be compared with the figure of 4 kw.-hr. per ton given by Trobeck (*16*) which included a liquor pump. (A mistake appeared in the earlier reference (*11*) where the power required should have been 1.43 kw.-hr. instead of 2.5 kw.-hr.)

From the practical standpoint the problems of the black liquor oxidation process are fairly well solved. Undoubtedly, however, further refinements will be innovated. Considering the "fume-heat-sulphur recovery process" as a whole, the development of the presently discussed oxidation system and the venturi-scrubber solve only two thirds of the problem. The third item is to make certain changes in the kraft recovery furnace so that it will better perform certain functions. The manufacturers of furnaces should be encouraged by the industry to investigate their own equipment and redesign it with the following objects in view:

1. To perform the drying, reduction, and smelting of the black liquor in the bottom part of the furnace in the fuel bed.

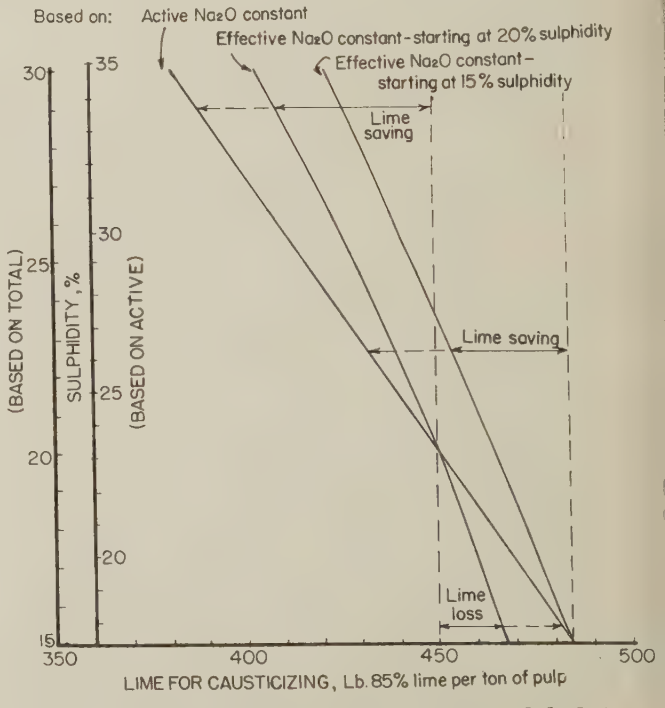

Fig. 2. Lime for causticizing at various sulphidities

Definitions
Active alkali = $NaOH + Na_2S$
Effective alkali = $NaOH + {}^1/_2\ Na_2S$
Constants
130 g./l.—Na_2O total
18 g./l.—residual Na_2CO_3 as Na_2O
550 lb./ton of pulp—active Na_2O

2. To utilize the secondary air and mix it with the burning gases above the reduction zone so that even under overload conditions the hydrogen sulphide released in the fuel bed will be burned to sulphur dioxide and thus can be recoverable by the venturi-scrubber operating on oxidized black liquor.

It is the same intuitive feeling that projected the development of the oxidation system and the venturi-scrubber that suggests that necessary basic furnace changes will be relatively simple and will further close the kraft recovery cycle against its present major loss of sulphur.

LITERATURE CITED

1. Collins, T. T., Jr., *Paper Trade J.* 136, No. 12: 37–40; No. 13: 19–22, 24 (March, 20, 27, 1953).
2. Kress, O., Can. pat. 490,654 (Feb. 17, 1953); same as U. S. pat. 2,570,460.
3. Tomlinson, G. H., and Tomlinson, G. H., II (Howard Smith Paper Mills, Ltd.), Can. pat. 494,697 (July 21, 1953); same as U. S. pat. 2,593,503.
4. Anon., *Pulp Paper Mag. Can.* 53, No. 13: 108 (Dec., 1952).
5. Wright, R. H., *Tappi* 36, No. 2: 85–88 (1953).
6. Schoening, M. A., Shemilt, L. W., and Wright, R. H., *Tappi* 36, No. 4: 176–179 (1953).
7. Wright, R. H., Schoening, M. A., and Shemilt, L. W., *Tappi* 36, No. 4: 180–183 (1953).
8. Court of Customs and Patent Appeals. *U. S. Patent Quarterly* 105: 272–275.
9. Tähtinen, M., *Paper and Timber* (*Finland*) 36, No. 2: 35–44 (Feb., 1954).
10. Ghisoni, P., *Tappi* 37: 201–205 (1954).
11. Collins, T. T., Jr., *Paper Trade J.* 131, No. 15: 30, 32–34, 36, 38 (Oct. 12, 1950).
12. Ross, J., and Miles, C. D., *Oil & Soap* 18: 99 (1941).
13. Collins, T. T., Jr., *Paper Trade J.* 129, No. 8: 29–33 (Aug. 25, 1949).
14. Daniels, F., "Outlines of Physical Chemistry," published by John Wiley & Sons, Inc., New York, N. Y. (1948). See page 467.
15. Hägglund, E., *Holz Roh-u. Werkstoff* 11, No. 7: 251–257 (July, 1953).
16. Trobeck, K. G., *Svensk Papperstidn.* 54, No. 18: 632–636 (Sept. 30, 1951); *Pulp Paper Mag. Can.* 53, No. 3: 225–229 (Convention, 1952); *Paper Trade J.* 135, No. 1: 27–37 (July 4, 1952).
17. Tomlinson, G. H., Tomlinson, G. H., II, Swartz, J. N., Orloff, H. D., and Robertson, J. H., *Pulp Paper Mag. Can.* 47, No. 9: 71–77 (Aug., 1946).
18. Bialkowsky, H. W., and DeHaas, G. G., *Paper Mill News* 74, No. 35: 14–16, 20, 22 (Sept. 1, 1951).

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Dry Chemical Fire Equipment in the Paper Industry

ROBERT A. SCHELDT

Until recently, many fire protection and safety officials in the paper industry have used dry chemical fire equipment primarily against class B (flammable liquid) and class C (electrical equipment) fires. A number of mills, however, have found this extinguishing agent effective against class A (burning ember) fires, too. The following report is based upon the experience of the following companies with dry chemical: Badger Paper Mills, Fort Howard Paper Co., Hoberg Paper Co. (Division of Mead Corp.), Marathon Paper Corp., Marinette Paper Co. (Division of Scott Paper Co.), National Container Corp., Nekoosa Edwards Paper Co., Wisconsin Consolidated Paper Co.

Generally speaking, the fire hazards of the paper industry are somewhat similar to those in the textile industry. A goodly amount of these hazards are in the form of lint and dust in and around paper processing machines. Although water will extinguish most of these fires, water damage frequently exceeds by far the cost of the damage done by the fire.

An effective way to reduce water damage against class A fires, a number of paper companies have found, is to use dry chemical fire equipment for the knockdown of the flames, after which complete extinguishment is achieved with only a small amount of water. In this connection, it should be pointed out that the use of dry chemical fire equipment for protecting paper mill hazards has had only limited use up to this time. This is because, in most cases, the extinguishers do not have a class A rating. Class A is the broad general classification for fires that burn with deep seated embers. Flammable liquids are rated as class B hazards, and electrical hazards are class C.

It is within the broad class A area that one thinks of normal paper mill hazards and looks to water as the primary and most effective means of extinguishment. However, study indicates that class A fire extinguishing equipment is actually not the complete protection for paper mill hazards.

The whole subject of class A fires can be broken down into several different fire extinguishing practices with as many applications and with more than just water as an agent. A class A rating actually has little to do with dry chemical capacity and its application in paper mills. One needs only to coat paper with wax and one has in effect changed initial ignition and burning condition to a class B fire. If the fire isn't reached in time and the wax burns off, a class A fire is added to the class B.

This combination class A and class B wax paper fire could be further complicated with a class C fire. A spark from an electric motor or static electricity can touch off paper lint or the flash fire hazards present in broke boxes. Such a combination of conditions requires fire equipment that can handle all three classifications of fire. The fire equipment that gives the fastest extinguishment with the least down time loss and the least loss through water damage or post-fire maintenance and repair is naturally the best fire protection. Dry chemical gives this compound protection when used with water-type equipment.

The use of water is greatly reduced when accompanied with initial dry chemical fire control and fire knockdown. The capacity, operator protection, and flexibility of dry chemical, plus reducing the fire to a point which can be controlled with only that amount of water necessary to quench the remaining embers, can save a paper mill many dollars in water damage and capital equipment losses.

The lack of a class A rating loses some of its importance in view of dry chemical's easy application, greater fire killing capacity, and speed in extinguishing or reducing fires to embers. It reduces water damage and the need for water, makes fire accessible, reduces flame, and controls the fire to the point where it can be handled by one man with hand portable or wheeled equipment. These extinguishers are recommended as adjuncts to water-type extinguishers, *not as replacements.* Dry chemical is especially suited for use around the various process machines where excessive use of water will cause hours of cleaning, and waiting for equipment to dry out, or water damaged parts to be replaced. This is a capital loss in time at the very least.

Dry chemical reduces class A fires to embers in seconds, allowing plant operators to apply the minimum amount of water needed to quench the remaining embers. It also extinguishes the class B oils and greases and class C electrical fires that accompany most paper machine fires. Quenching can be done directly on the embers with first aid equipment. There is no need to employ large hose lines. Where it has been used, at least 60% of the post-fire time could be eliminated.

To be more specific water damage to a paper machine is of

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extreme importance. Such machines originally cost in the thousands of dollars. The loss of production will cost on an average of hundreds of dollars every hour the machine is shut down.

When water is used to extinguish a fire in or around a paper machine, there is always the danger of destroying the drier felt as well as causing severe damage to the drier rolls. The original cost of either of these two items is great, but very often the loss of production is greater. Then, too, there are still many paper mills in which the paper machine is driven with steam, which means felt driers. When these felts get wet with water it often takes 2 to 4 hr. to dry them out sufficiently to operate the machine.

It is a known fact that the use of dry chemical for bearing fires, hood fires and other common fires around paper machines has reduced the down time from 5 hr. to 2 hr.

The best way to illustrate the application of dry chemical equipment in a paper mill is to take each department in order.

WOODYARD

The woodyard is a constant concern of mill operators. These are large, hard to protect storage yards. They are quite vulnerable to such hazards as switch engines, cranes (steam or diesel), motor vehicles in poor operating condition (e.g., some old trucks of farmers selling logs to the mill), and careless smokers. These present real problems because many mills do not have hydrant protection in the yards but rely on such less effective protection as 55-gal. water barrels in strategic locations and strict enforcement of fire precautions.

Some companies have taken steps to reduce these fires by placing spark arrestors on the steam locomotives and cranes. Other companies have replaced the steam engine and crane with diesel operated engines and cranes and threaten to discharge a person for smoking in this area, but in spite of all this, the hazards have just changed their color. A few of the mills today are just now beginning to realize the advantage of having dry chemical fire equipment on their diesel locomotives and cranes as well as at the unloading dock. This is because water doesn't always extinguish a hot brake drum fire on a log crane, a fuel oil fire on a diesel locomotive, or a gasoline or an electric fire that might occur in a truck.

WOODROOM

Generally speaking the fire hazards in a woodroom are not too great for the logs have usually been in the water just long enough to prevent them from becoming readily ignited. The main hazard in this department, especially the newer mills, is the numerous electric motors. A secondary hazard is the accumulation of fine saw dust.

Even though dust is a secondary hazard, it could very easily result in a minor dust explosion or a death taking flash fire. This is not an assumption for it actually happened in a mill in the Lake States area. In this case, one of the electric motors caught fire as a result of an overload. The housekeeping was poor and fine saw dust had been allowed to accumulate. The motor fire ignited the surrounding saw dust. One of the employees brought into play the only fire protection equipment available, a $1^1/_2$-in. fire hose. The velocity from the water stream stirred up the fine saw dust, resulting in a large flash fire. The flash occurred just as another employee rushed into the room to help extinguish the fire. The man caught in the flash lost his life.

This would not have occurred if a dry chemical extinguisher had been used on the motor fire. Even though this type of extinguisher would also have stirred up the dust, the particles of dry chemical would have intermixed with it. In other words, the chemical particles would have absorbed the heat away from the sawdust particles and, in so doing, generated an inert gas which would have eliminated the flash fire. The dry chemical would have been in large enough concentration to eliminate the flash fire.

Two 20-lb. dry chemical fire extinguishers are recommended as additional protection for the woodroom.

After the logs have been properly processed in the woodroom the chips are transported to the chip storage bins by conveyor belts.

CHIP BINS

Chip storage is primarily a class A hazard well protected with water sprinklers and standpipe and hose, but use of large electrical motors and conveyor belts makes the installation of dry chemical fire equipment advisable. Experience shows that most of the fires originating in this department are in the motors, though the fine, dry dust that accumulates presents the same hazard here as it does in the woodroom. An Ansul 20-B is recommended as minimum protection for this operation.

DIGESTER ROOM AND BLOW PIT ROOMS

The hazard in these locations is again electrical with some dust problems in the digester room. Protection requirements are best determined during a fire protection survey of the mill.

ACID MAKING DEPARTMENT

Main hazard is sulphur and electric motor fires. One or two dry chemical extinguishers will play an important part in this area and especially so in the sulphur melting or burner room. Fires are quite common here, but most of them are not too serious because they can be readily extinguished well before they get out of control. Most can be extinguished by water, which is quite positive on sulphur. Water, however, if used unwisely, can cause considerable inconvenience to the operator, especially if the fire occurs in the melter.

First let us start with the raw sulphur storage bins as fires here are not too common, yet happen just frequently enough to make it worth while mentioning. They are caused by electric wiring short circuit. There is bound to be sulphur dust collected on the wiring, walls, etc. When a short circuit occurs, the sulphur on the wires will naturally start to burn. As the sulphur melts, it will drop on top of the main stock pile, igniting the stock pile. As long as the burning molten sulphur remains in pools on top of the stock pile it is rather simple to extinguish with water or dry chemical. Extinguishment with water causes the molten sulphur to cool and form a crust. This can be broken up when used later on. But when the sulphur surrounding the burning area becomes wet and hasn't had sufficient time to dry, boiling and bubbling occur in the melter, resulting in a crust being formed over the molten sulphur. This crust prevents melting of fresh sulphur entering the burner. The end result is hand firing by the burner operator and decreased efficiency.

The stock pile hazard becomes more difficult if the burning sulphur flows to the outer bottom edge of the pile. If it does fire eats its way inside and hollows out the pile. When this happens the fire is very difficult to extinguish.

Two other possible hazards in the acid room are an overflow from the burner and allowing the melter to go dry. The overflow occurs only when the operator forgets to shut off the control valve. When it does happen the burning sulphur will usually drop onto the drive chain, spreading to the hopper room. Here again the fire isn't too severe unless the operator neglects to supervise the area properly. There is a possibility that the fire would spread over the entire room, including the walls and hopper conveyor, because of the ever present sulphur dust.

Water can be used successfully in this department but a 20-lb. dry chemical unit would be valuable for quick knock down and control of the fire.

TOWER ROOM, SCREEN ROOM, AND WET ROOM

Electric motors are the only hazards in these departments.

BEATER ROOM

Electric motors are the primary hazard in the beater room, too, but the possibility of fire breaking out in "broke" piled too close to a motor creates a more remote, but additional hazard. Except for the electrical fires water can be used without fear. Besides protecting the electrical equipment, dry chemicals would play an additional part in this department by knocking down and stopping the spread of fire in the broke pile.

Many mills produce wax paper, special meat wrapping papers, and other similar coated products, all of which incorporate wax coating. Wherever these wax papers are produced, there will be fire hazards in the form of wax dip tanks and wax coating machines. Portable and wheeled dry chemical extinguishers will provide excellent protection for these hazards. Water is not recommended as it will result in damage to the paper in process plus the fact, if water is applied to a wax dip tank, there is the extreme danger of "boil-over" thus a spreading of the fire. The quick action of dry chemical will often extinguish the wax fire (in the wax-coating machines) before the paper has had a chance to burn. This, of course, eliminates long periods of repair and clean-up, eliminating costly unproductive down time. A Scott plant in Hoboken, N. J., has installed a 500-lb. dry chemical piped system to provide protection for the "hard to get at" areas under the wax-coating machines.

PAPER MACHINES

It is in the machine area where dry chemical fire extinguishers are extremely valuable. Their ability to knock flames down to glowing embers in class A hazards (if not actually extinguished) can save a paper mill thousands of dollars in water damage, down time, and loss of production.

Fire is not overly common but common enough to be a source of concern. When it does break out the fire is most apt to be caused by hot bearings, short circuits, or static electricity. Any of these may ignite the dust that has collected around the machine, especially in the hood above the machine.

The hood over the paper machine serves the same purpose as the hood over a restaurant cooking range. It exhausts excess heat and collects dust particles rising from the machine. Its stack contains a fan to develop a draft. The construction of the hood and stack makes it difficult to fight a fire in them, especially if a fire hose is used from the floor level.

Even though some mills have installed sprinkler heads inside hoods they still try to extinguish fire before the sprinklers operate. The deluge that comes from the heads soaks the machines, resulting in hours of unproductive down time while the machine dries out and perhaps hundreds of dollars in repairing or replacing water damaged parts. For example, a mill in the Lake States area once had a hood fire resulting in $32,000 damage—$34,200 water damage.

One of the divisions of the Scott Paper Co. has installed two 150-lb. dry chemical units in its mill. Even though the hoods are adequately protected by sprinklers, dry chemical is used to quickly control fires before the sprinklers are released.

Average down time from fires extinguished with water was found by one of the Wisconsin-Michigan paper mills to be $6^1/_2$ hr. When they switched over to dry chemical protection, down time was cut to a maximum of $1^1/_2$ hr. As a result of this finding this company has completely ignored the lack of class A approval and installed dry chemical. The company, of course, still maintains the required amount of class A protection specified by its insurance company and uses it when needed for quenching smoldering embers that might be remaining. Its equipment consists of three 30-lb. extinguishers around each of four paper machines and one wheeled extinguisher located where it can be brought into play on any one of them.

High velocity, long range nozzles are best suited for the paper machines room especially for fires occurring in drier roll bearings. These bearings are somewhat protected by the gear wheel. The wheel's speed in revolving acts as a fan and a barrier, stopping an ordinary nozzle's stream from getting through. The high velocity nozzle's stream is able to penetrate and extinguish the fire.

The long range nozzle enables an operator to fight a fire high on the machine without having to get close to the gears.

There are other places for dry chemical fire extinguishing equipment besides the operating floor level. For instance, in some mills the machine extends through the floor. The part below the operating level presents the problem. Its inaccessibility makes it difficult to fight a bearing fire occurring below the operating floor level. Water can do a lot of damage, even to washing the grease out of the bearing box, and can cause long periods of shutdown. Fighting such a fire from the operating level without stopping the machine creates a safety problem for the operating personnel. It is best to attack the fire from the basement level, preferably a unit with a long range nozzle.

In many cases the broke from the machines is blown to the basement level. Fires occur when the broke is allowed to accumulate around large open phase motors. When such a fire occurs it can spread rapidly up into the machine.

It is recommended that either 20 or 30-lb. extinguishers with long range nozzles be used around the paper machines. The exact number can best be determined by survey of the machine installation.

There are many other places in or around a paper mill where dry chemical would be the best and proper protection: boiler room, overhead electric cranes, lift trucks, electric generator rooms, transformer vaults, large generator motors, engine rooms, elevator shaft motors, welding machines (electric and acetylene), oil switch panels, finishing rooms, solvents, sodium peroxide, and other chemicals. The best way to know fire protection needs is to survey the plant and have recommendations made by a competent person.

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Fifth Corrugated Containers Conference, Morrison Hotel, Chicago, Ill., October 5–7, 1955.

Twelfth Agricultural Fibers Conference, Alton, Ill., October 13–14, 1955.

Ninth Alkaline Pulping Conference, Hotel Patten, Chattanooga, Tenn., October 19–21, 1955.

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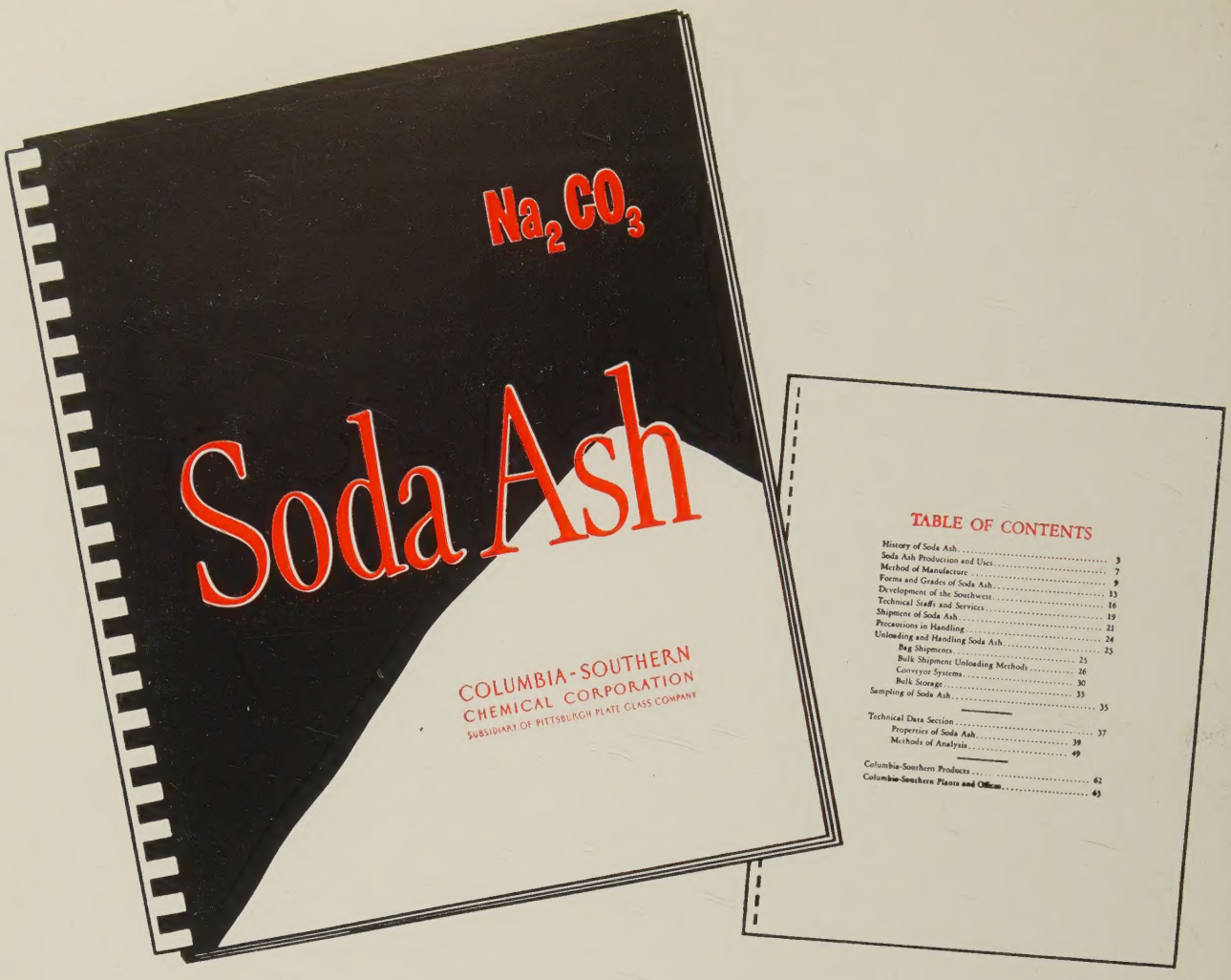
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